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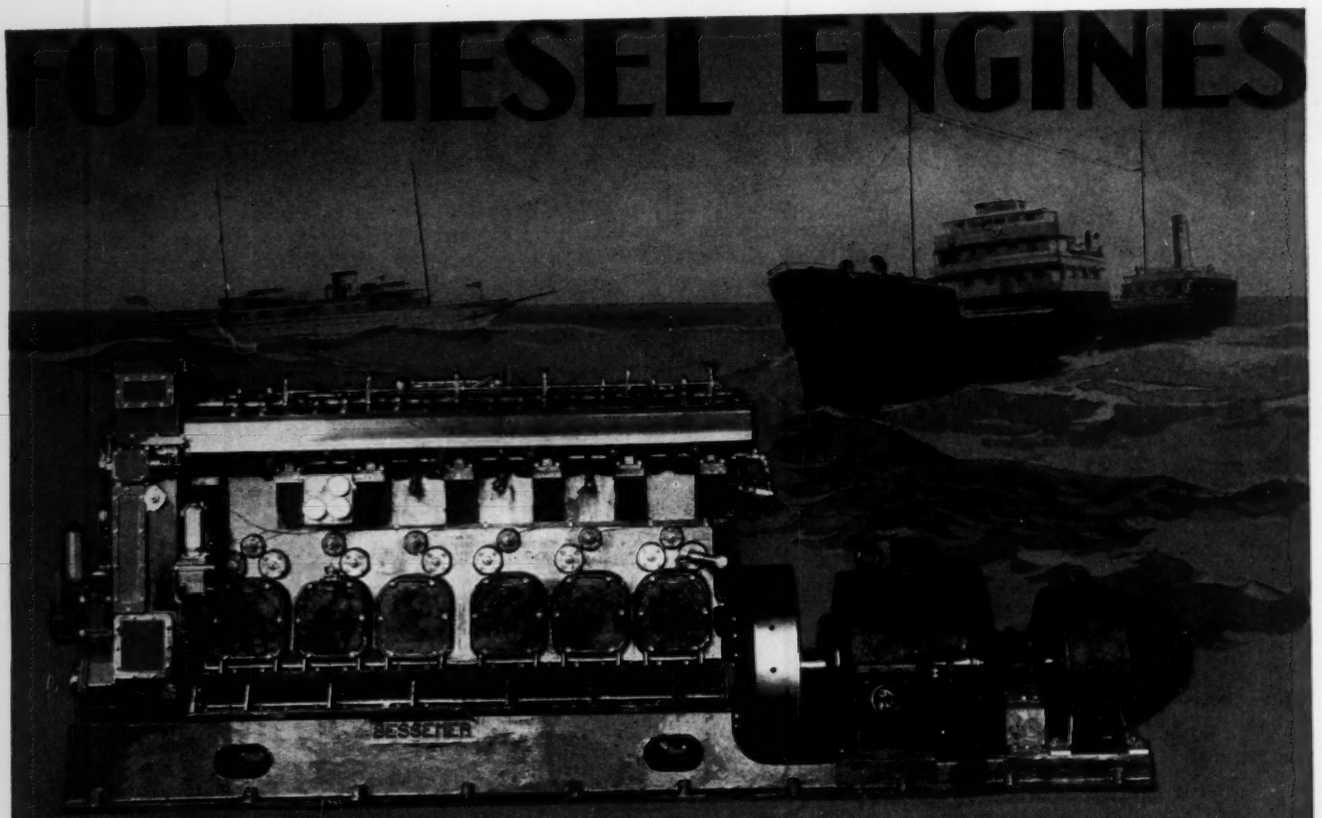
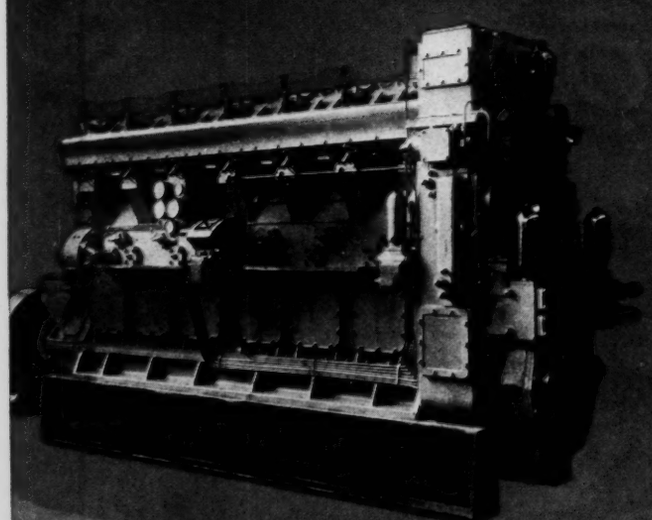
MACHINE DESIGN

AS IT AFFECTS

ENGINEERING—PRODUCTION—SALES

FOR DIESEL ENGINES





The upper illustration is a Cooper-Bessemer Diesel engine-generator unit for the tanker "Tidemotor" of Tidewater Oil Co. The lower picture, another Cooper-Bessemer unit in the private yacht of Mr. George L. Craig, Long Beach, California.

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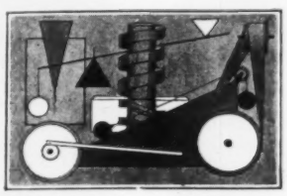
ENGINEERING–PRODUCTION–SALES

Volume 3 | **February, 1931** | **Number 2**



Forthcoming ISSUES

IN AN article on design of air conditioning equipment which appears in this issue, reference is made to the replacement of air operated controls by electrical units. This is just one of the many instances indicative of the trend toward the adoption of the electrical method of controlling or operating machines and mechanisms. The tendency, however, is widespread.

In line with MACHINE DESIGN'S *policy to publish timely and authoritative information on new methods, materials and parts, a comprehensive article dealing with numerous phases of electric control equipment will be included in an early issue. Other discussions of the subject will follow in subsequent numbers.*

L. E. Jermy.
Managing Editor

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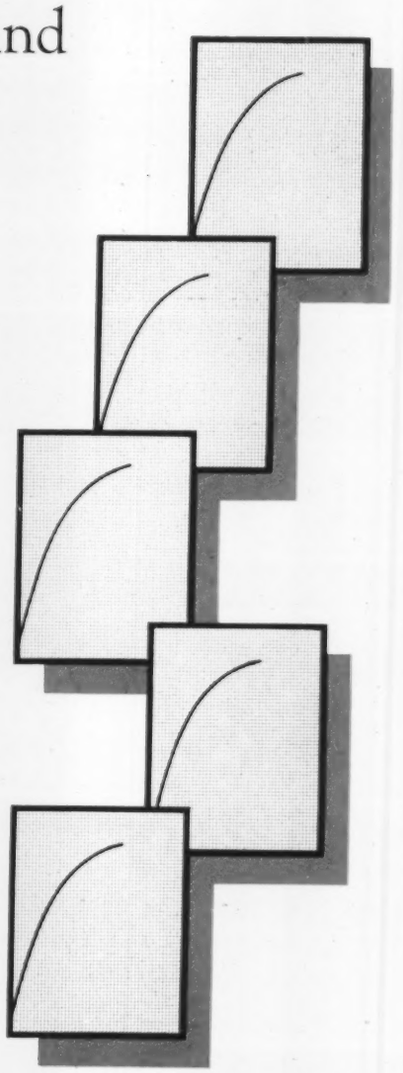

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EVERY engineer responsible for the design of machines recognizes the value of manufacturers' catalogs and other trade literature. In many cases these booklets contain important data that cannot be found elsewhere. Often the designer's task is simplified if he has available an extensive file of such literature.

Machine Design lists and reviews trade publications in all fields important to the designer. The section is entitled "Manufacturers' Publications" and appears in this issue on page 78. Publications listed in this section may be obtained without charge from the manufacturers of the products or through Machine Design.

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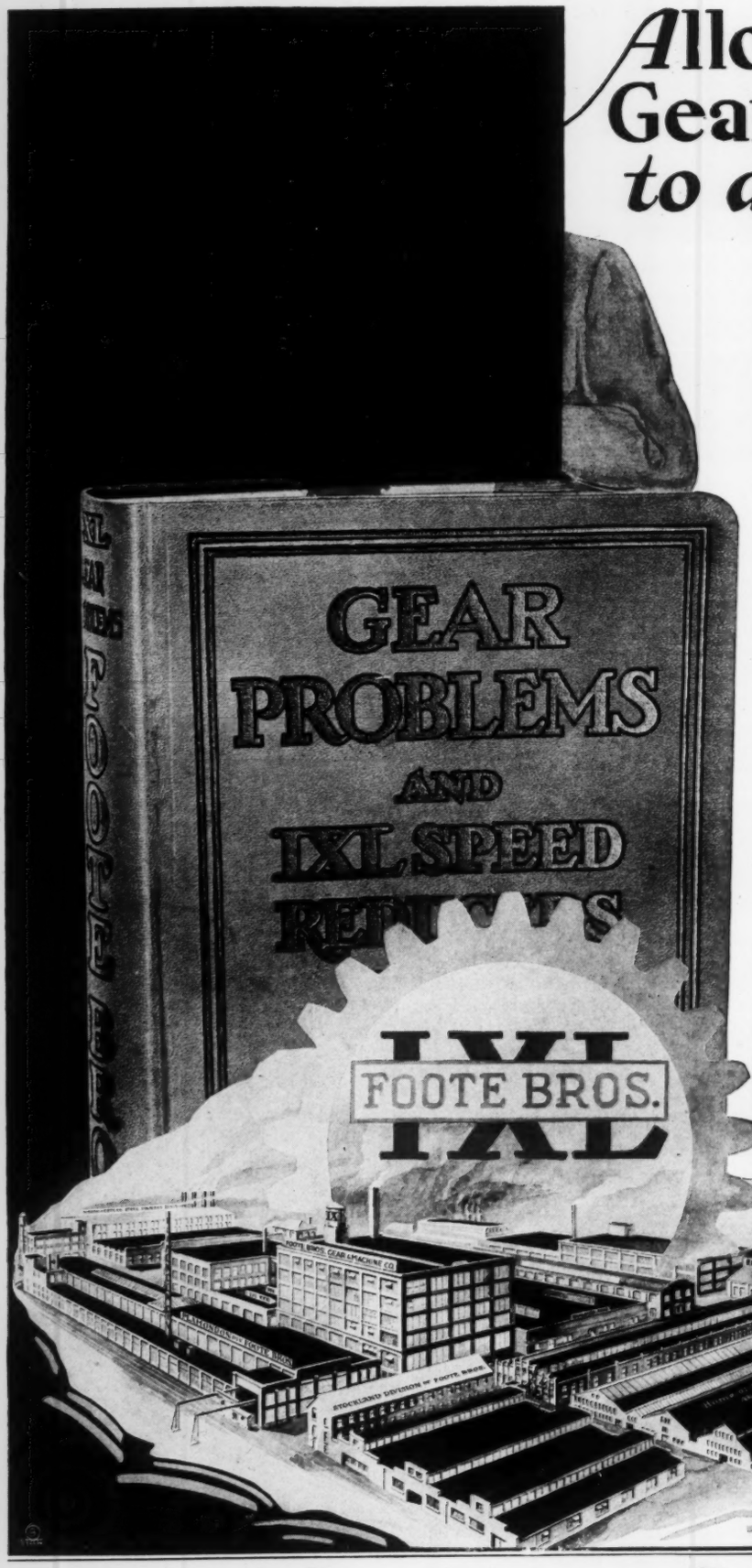

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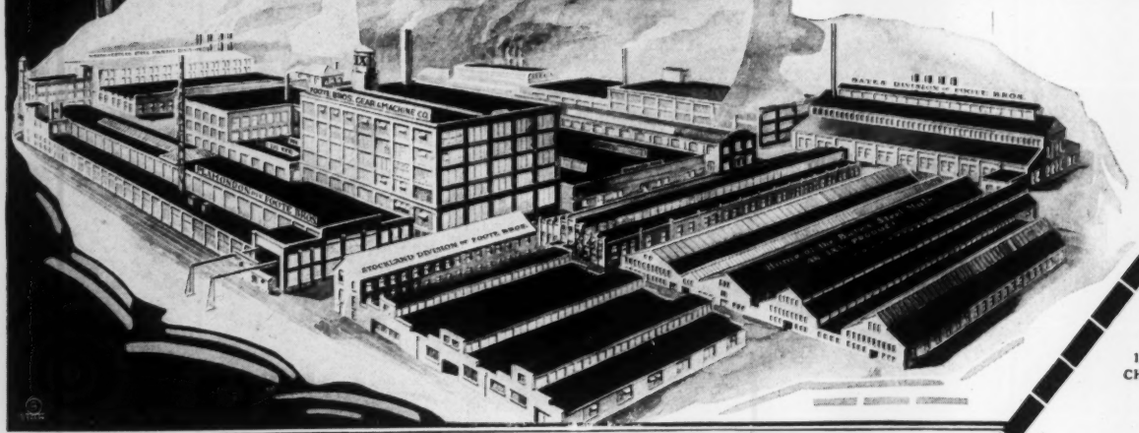

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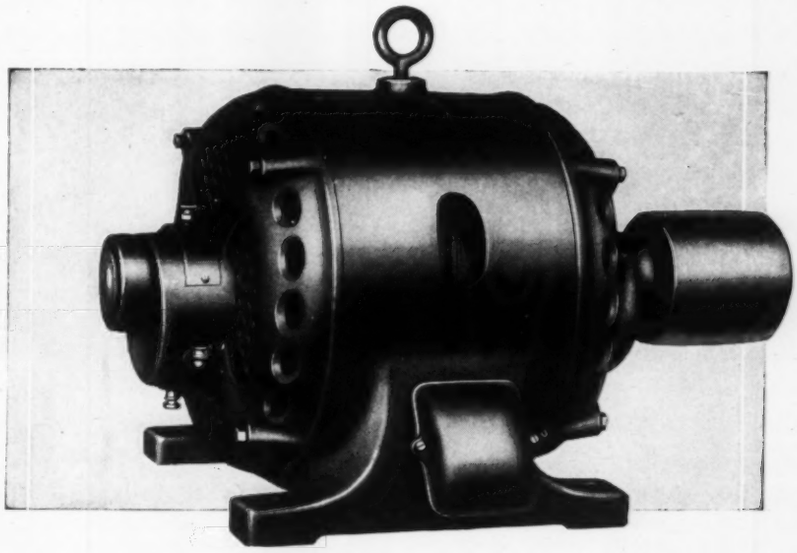

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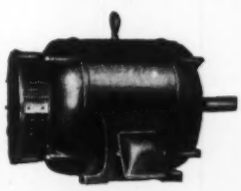

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CALENDAR OF MEETINGS AND EXPOSITIONS

Feb. 16-19—American Institute of Mining and Metallurgical Engineers. One hundred and fortieth meeting to be held in New York. The annual reception and dinner will take place at Hotel Commodore, Feb. 18. Technical papers to be presented include, "Inclusions and Their Effect on Impact Strength of Steel," by A. B. Kinzel and W. Crafts; "The Permanent Growth of Gray Cast Iron," by W. E. Remmers; "Some Notes on Blue Brittleness," by Leland Russel van Wert; "Extraction of Tantalum and Columbium from Their Ores," by Colin G. Fink and Leslie G. Jenness; "X-Ray Determination of Alloy Equilibrium Diagrams," (Institute of Metals division annual lecture), by Arne Westgren; "Plasticity of Copper-Zinc Alloys at Elevated Temperatures," by Alan Morris; "Plastic Deformations," by F. Wever; "Effect of Combinations of Strain and Heat Treatment on Properties of Some Age Hardening Copper Alloys," by William L. Fink, Kent R. Van Horn and P. M. Budge; "Suppressed Constitutional Changes in Alloys," by G. Sachs. W. M. Corse, 29 West Thirty-ninth street, New York, is secretary of the organization.

Feb. 16-20—Western Metal congress. Second National Western Metal congress and exposition to be held in the Civic Auditorium, San Francisco, under the auspices of the American Society for Steel Treating. Cooperating with the society are 12 other national technical organizations and local groups. Headquarters for the congress will be maintained at St. Francis hotel where technical sessions will be conducted at 10 o'clock each morning of the five days. Among papers to be presented will be, "Improvements in Physical Properties in Large Carbon and Alloy Steel Castings," by J. Fensternmacher, United States Steel Products Co., San Francisco; "Manganese Steels," by D. H. Young, American Manganese Steel Co., Oakland, Calif.; "High Test Cast Iron," by F. B. Coyle, research laboratory, International Nickel Co., Bayonne, N. J.; "Failure of Machine Parts," by L. T. Holt, consulting physical metallurgist, Seattle, Wash.; "Metallurgy of Welding," by Paul Jeffers, Los Angeles; "Automotive Steels," by J. M. Watson, metallurgical engineer, Hupp Motor Car Co., Detroit; "Welding Aluminum and Its Alloys," by W. M. Dunlap, research metallurgist, Aluminum Co. of America, New Kensington, Pa.; "Shape Cut Steel," by C. E. Rhein, Linde Air Products Co., San Francisco; "Structural Arc Welding," by A. F. Davis, Lincoln Electric Co., Cleveland; "Nitriding," by Dr. O. E. Harder, Battelle Memorial institute, Columbus, O.; "Creep of Metals at High Temperatures," by P. G. McVetty, research engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; "Recent Developments in Corrosion Prevention of Ferrous Metals," by F. N. Speller, and V. V. Kendall, National Tube Co., Pittsburgh; "Chromium and Chromium-Nickel Steels," by C. C. Snyder, Republic Steel Co., Massillon, O.; "Corrosion and Lubrication of Valves," by G. F. Scherer, Merco-Nordstrom Valve Co., San Francisco. The exposition will comprise over 70,000 square feet of floor space. Approximately 150 exhibitors have reserved space and of this number perhaps three-fourths are from the eastern states. W. H. Eisenman, 7016 Euclid avenue, Cleveland, is directing the congress.

Feb. 24-27—Western Tractor and Power Farm Equipment Show. Thirtieth annual event sometimes called the "Style Show" of the power farm equipment industry, to be held at Wichita, Kan. Exhibits will include a complete line of the latest models of power farming machinery. It is the largest exposition of its kind in the world. The Southwest Road show and school will be held at the same time in Wichita.

March 1-7—Leipzig International Trade fair. Seventy-two countries in all parts of the world will be represented at this historic exhibition which is to be held at Leipzig, Germany. Engineering, materials and equipment divisions will be made up of 2231 displays of manufacturers from all parts of the world. Exhibits of machines, apparatus and materials are estimated to cover an area 1,400,000 square feet, housed in 17 halls and also set up out-of-doors. Complete information concerning the fair may be obtained from Leipzig Trade Fair Inc., 11 West Forty-second street, New York.

March 16-22—Oil Equipment and Engineering Exposition. A technical and scientific gathering of latest developments in machinery and instruments of the oil industry to be held in Los Angeles. Various technical societies are planning meetings in connection with the exposition. E. G. Lenzner, Box 781, Vernon station, Los Angeles, is manager of the affair.

April 12-16—American Society of Mechanical Engineers. Joint national meeting of the materials handling and management division to be held in Cleveland at the time of the industrial equipment exposition. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary of the society.

April 13-18—American Oil Burners association. Eighth annual convention and oil burner show to be held in Benjamin Franklin hotel, Philadelphia. Harry F. Tapp, 342 Madison avenue, New York is executive secretary of the association.

MACHINE DESIGN
THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO
February, 1931 Vol. 3—No. 2

Photoelectric Cell Is Design Engineer's Latest Ally

By Edgar H. Felix

Fig. 1—This unit, for turning on and off the lights in a factory, suggests numerous uses

LIGHT sensitive devices constitute the first radically new equipment in several years to come to the aid of the machine designer. Development of automatic machinery has been largely the evolution of mechanical substitutes for human labor. But light sensitive devices are in an entirely new category; instead of substituting for labor they replace human judgment while retaining the accuracy, uniformity and tremendous speed inherent in an electric current.

WATCH progress in employment of photoelectric equipment! Revolutionary strides are being made. Numerous applications and potential uses are described in this article, the first of two on the subject. Others are detailed in the article to appear in the March issue and information on the design and method of applying the units also is given. The author has had many years experience in this and allied fields. He is consultant with Miller, Franklin & Co., industrial engineers, Madison Avenue, New York.

Fundamentally, the photoelectric cell operates like the rods and cones on the retina of the eye. Its output fluctuates in a manner corresponding to light fluctuations directed to it. By means of suitable optical systems, such fluctuations can be restricted to represent a significant variation of color or shading heretofore controlling a human sense judgment. Producing an electrical variation corresponding quantitatively to the light fluctuation, it requires but a simple electrical transformation to use light and color changes for controlling any manufacturing operation.

Stated thus abstractly, the full significance of the light sensitive device is difficult to appreciate. It is accurate to state that any single judgment of color or light intensity performed by a skilled worker can be accomplished electrically with greater accuracy and tremendously increased speed by means of light sensitive de-

vices. In short, we can see electrically and utilize the effect of electrical vision to almost any conceivable purpose; the electric eye not only judges but acts instantly in accordance with its decision.

Perhaps more important than mere duplication of eye response are three marked superiorities of the light sensitive system over the human visual system: (1) its precision, (2) its instantaneous response, and (3) its freedom from

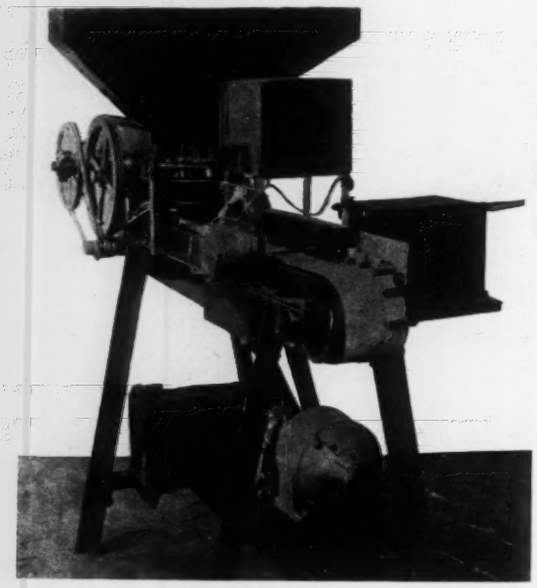


Fig. 2—Electric eye counting lamp socket bases on moving belt conveyor

fatigue. The trained eye can discriminate a one or two per cent change in color; the photoelectric system is capable of ten times that accuracy. The human observer is limited to a few accurate judgments per minute, but photoelectric systems can respond to thousands of impressions per second, as evidenced by any talking motion picture performance. Furthermore, the light sensitive system is as accurate and efficent during the eighth hour of the day as during the first.

Classes of Light Response Systems

There are four general classifications of light sensitive devices employing photoelectric cells:

(1) Those responding to mere presence or absence of light without regard to its intensity or color;

(2) Those responding proportionately to the total light intensity impressed upon them;

(3) Those depending upon reflection or conduction of light of a particular frequency or color, and

(4) Those responding successively to each color of the spectrum and controlling operations according to variations of any or every color constituent.

Before proceeding with a discussion of the design details of these various classifications of light sensitive instruments, practical illustrations of applications already made will be considered. It must be realized, however, that only a meager start has been made in developing such applications. This slow progress is due largely to the fact that the electrical equipment required for each such application is almost negligible in cost. The extensive experimental work often necessary to perfect an application is not, from the standpoint of equipment manufacturers, justified by the prospective sales of parts and replacements. Consequently the initiative for special development work must be borne by the industries benefited rather than the makers of light sensitive components. While this situation obtains, it is probable that progress will continue to be slow, in spite of the numerous possibilities of increased production, lower costs and greater uniformity opened up by the utilization of light sensitive devices.

Circuits Closed by Light

The simplest classification of light sensitive devices are those which act upon the mere absence or presence of light. The output device controlled may be made to respond when more than a certain value of illumination is impressed on the photoelectric cell or it may be made operative when illumination falls below a desired value.

When daylight intensity is used as the controlling factor, the photoelectric cell is exposed to normal daylight without the intermediary of an optical system. Obvious uses of such systems are the control of electric signs when daylight illumination reaches a value which will make the sign unreadable from a distance. The use of the photoelectric cell in preference to a time clock arrangement gives the electric sign advertiser the advantage of extra utilization on dark

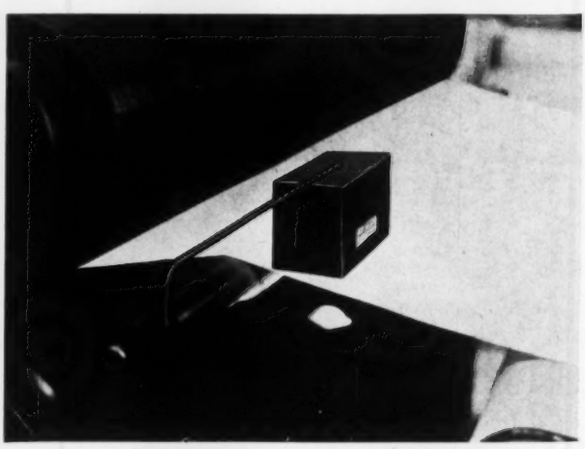


Fig. 3—This instrument stops the paper machine instantly if web breaks

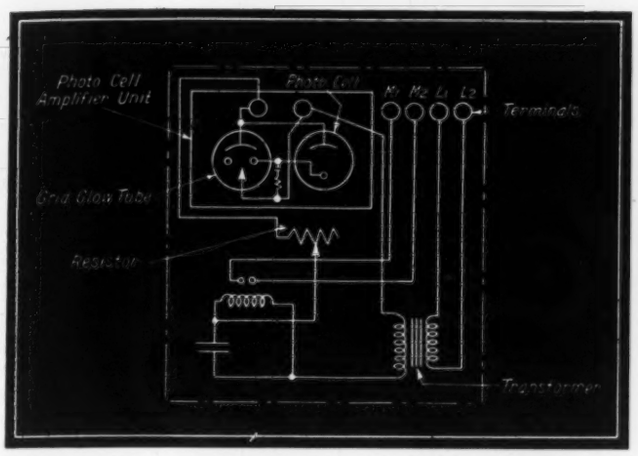


Fig. 4—Wiring diagram for application such as that shown in Fig. 3

days and the advantage of the economy gained by shutting off the power to the sign at the moment increasing daylight reduces its effectiveness.

Similar in principle are light sensitive devices used as fire alarm and burglar warnings. If illumination conditions normally are dark, as in the hold of a ship or in a warehouse, it may be desirable to have warning of any illumination present. The same general system used for electric sign control is of course applicable.

Photoelectric cell systems are being used successfully for controlling artificial illumination in factories and schools when natural illumination fails, avoiding the usual delay in providing adequate illumination for safety and efficiency. At the same time substantial economies are effected because lights are cut off the moment daylight illumination has again reached a satisfactory level.

In large plants, cutting off illumination a few minutes sooner after a thunder storm than usually is done by manual control often is sufficient to effect substantial economies.

The arrangement of an intense beam of light directed to a photoelectric cell can be used to operate automatic counting machines. To count the persons entering a hall, a unit at each entrance will give an accurate record without inconvenience or noise of a turnstile. A similar set-up is used extensively for counting containers on a moving belt without the mechanical difficulties encountered when star wheel arrangements make physical contact with the elements being counted. A machine for counting lamp socket bases is shown in Fig. 2.

No Limit to Speed of Operation

The photoelectric cell has no limit to the speed with which objects may be paraded before it. In a large can factory cans are counted on a moving belt at the rate of hundreds per minute. If the counted objects appear irregularly, or spasmodically, there is no danger of reducing vigilance of false count. The cars passing through the Holland Tunnel are counted by means of a photoelectric system. Being electrical in its responses, the count can be arranged to register remote from the scene of the installation. A plant manager may have in his office a continuous and instant graphic count of the actual output of every machine in an extensive plant. The same type of device can be used for giving warning of exhaustion of supply of raw material to automatic machines, or for safety purposes so that an operator cannot approach any dangerous machine without automatically cutting off the power supply.

Photoelectric counting devices often can be applied where mechanical contact counters cannot be used because of physical conditions. In at least one steel plant, for example, red hot ingots are counted with a photoelectric system.

Visible Light Is Not Required

Prowler alarms depending upon simple interruption of illumination can be used in most factories by placing light sensitive units in such a position that an intruder will be expected to intercept the rays from light used normally during nonoperating hours. But photoelectric devices capable of acting as warning devices in complete darkness have been developed. A device worked out for the protection of bank vaults directs a ray of infra red light to the vault, which must be intercepted to approach its door. Infra red is invisible to the eye but photoelectric cells can be made to respond to it. Hence this particular alarm device does not have a tell-tale spot of light to reveal its presence.

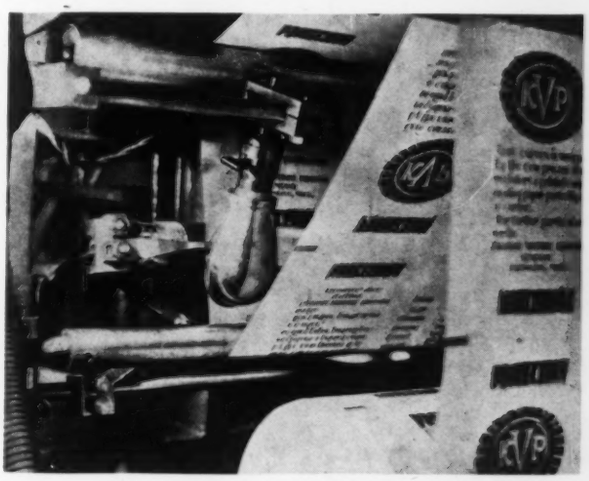


Fig. 5—Light source used in paper registering control on wrapping machine

With most safety and warning devices, it is possible to make them check their own functioning as well as to act as guardians. When the actuating illumination is withdrawn, when the photoelectric cell through long use, loses

sensitivity, or when the battery becomes disconnected, the photoelectric cell output falls and thereby initiates the operation assigned to it.

The finish of raw metal is being successfully inspected by photoelectric means. Sheets of polished metal are passed before a bank of photoelectric cells and powerful illumination is reflected to them. Properly finished material reflects a certain value of light. When the reflection falls below that standard, the photoelectric system gives automatic warning of a surface blemish. Because of the great monotony of observing metal sheets passing by hour by hour, human inspectors fail frequently in their task. The photoelectric cell is capable of observing accurately and untiringly a much greater quantity of material than a considerable number of human inspectors.

Photoelectric systems have been evolved which maintain continuous control according to illumination, as distinguished from those which

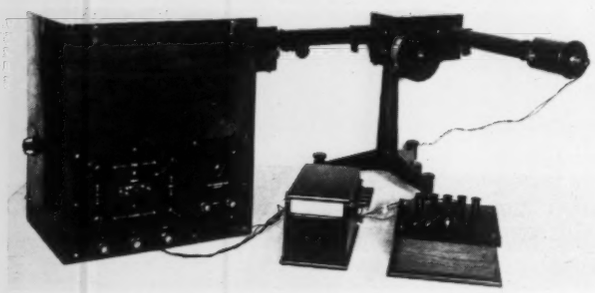


Fig. 6—Photoelectric spectrophotometer for laboratory measurement of samples

become operative when a specific value of illumination is reached. A continuous record of natural illumination can be maintained automatically in the same manner as temperatures now are recorded on clock-driven recorders. A further ramification of such a device in an electric power plant would be to turn on additional generators automatically as darkness falls.

The control of smoke density from a factory stack is important not only to assure compliance with municipal regulations, but in maintaining economical combustion. A commercial light sensitive unit is available which maintains a continuous graphic record of smoke density and sounds a warning bell when a certain value of density is exceeded.

Photoelectric measuring methods are used by New York state public health officials to measure the amount of residual chlorine added to municipal water supply systems. They also are used to maintain a check and to control the ventilating system of the Hudson Tube, giving warning when certain minimum smoke and fume density is exceeded and controlling automatically the speed with which the ventilating system is operated.

In paper manufacture continuous measurement of whiteness is made so that uniform standards are maintained. Fig. 3 shows a unit for stopping machine if paper breaks. Roasting of coffee which requires shutting off the ovens at a critical moment in the roasting process is being attempted photoelectrically. This suggests unlimited possible applications in the baking and packing industries. The grading of food products by color already has received some attention, Hawaiian pineapples are now being sorted uniformly in several categories by high speed photoelectric measurements.

Sorting of cigars according to shade was one of the first general applications of light sensitive devices to color grading. Apparatus was developed which grouped cigars into ten shades, the output of the photoelectric cell system directing and controlling the electro magnetic device which put the cigars in their respective containers. Another operation of comparatively long standing application is the sorting of black and white beans by shade, an operation heretofore performed manually.

The nature of the problems which can be solved with photoelectric devices involving detection of the presence or absence of a particular color, the third major classification of light sensitive devices, is indicated by a recent feat of a manufacturer of wrapping machines. In certain grocery products, wrapping the container with waxed paper improves the standard of freshness which the consuming purchaser receives. On the other hand, the use of waxed paper obscures the label, an important factor in securing the full benefit of window and shelf display. The paper now is printed exactly like the package, but great difficulty was experienced in making the design printed on the waxed paper match accurately with the printing on the container. A photoelectric system is used, Fig. 5, to match patterns by making correction for slight variations in container size and wrapper shrinkage automatically.

Photoelectric Spectrophotometry

The final classification of light sensitive devices covers those depending upon measurement of each color frequency constituting the visible spectrum. Unlike the devices already described, their operation is not instantaneous but requires a series of measurements, the number being dependent upon the accuracy of result required. With certain photometers already developed, the color curve is made automatically from the sample.

The principal use for color analysis is for laboratory investigations. Frequently laboratory analysis throughout the color scale shows that measurement of but one or two places on the color scale reveals all the essential information in a product, thus bringing photoelectric analysis on an automatic high speed basis.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

ONE of the most fascinating features in the development of manufactured products is the constant migration of ideas from one industry to another. There is a steady interchange of design experience, whereby a worthy achievement in one field of engineering soon finds its way into others.

At the time the automobile was in the early stages of development, its designers borrowed ideas and experience from the builders of railroad cars, locomotives, street cars, bicycles and many other types of machinery. Many of these ideas were modified or refined to meet the requirements of motor car manufacture, and before many years had passed, the automotive industry was lending ideas to other industries. In fact, it more than repaid its earlier debts in that respect.

Transference of Ideas Beneficial

AMONG those who profited most from ideas borrowed from the designers of motor cars were the builders of airplanes. Undoubtedly, development of heavier-than-air craft would have been seriously retarded if it had not been for the assistance given by the automobile industry.

But now the airplane is beginning to repay its debt to the motor car. In the opinion of a number of authorities, one of the next important advances in the evolution of the automobile will be the application of the laws of aerodynamics to the design of motor car bodies, fenders, lamps, windshields, etc. And in this development, the influence of airplane experience is bound to play an important role.

Automobile designers now are taking steps to reduce to a minimum the resistance encountered by a car traveling at high speed. This tendency is illustrated by the lines of the new Reo-Royale, which was designed in accordance with studies of aerodynamics.

In developing and testing the new Reo-Royale quarter-size scale models of the new car and of the Reo Flying Cloud of last year were constructed. These models were mounted as shown in Fig. 2 in the wind tunnel of the aeronautical division of the University of Detroit and were subjected to air velocities ranging from 30 to 80 miles per hour. Readings of the pressure exerted by the wind against the two bodies were taken every five miles per hour throughout the range covered in the tests.

The method of hanging the models gives a wind effect similar to that produced when the car travels over the road. The resistance of the fine suspension wires is negligible.

Another important part of the tests was the investigation of the movement of the air and

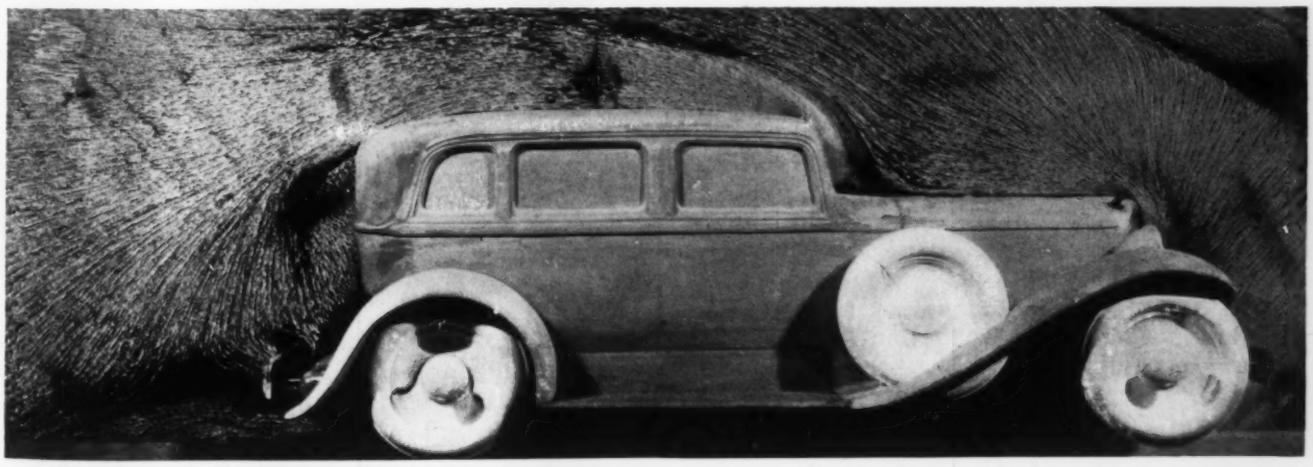


Fig. 1—This model of the Reo-Royale with enameled plate smeared with kerosene and lamp black, when placed in wind tunnel, gave designers data on direction of air travel

of the location and nature of eddy currents and pressure and suction areas. Fig. 1 shows the results obtained by fitting an aluminum plate to the Reo-Royale at the longitudinal center line. The plate, enameled dull white, was coated with a mixture of kerosene and lamp black. When the draft was turned on the kerosene, flowing under the influence of the air, scoured channels in the lamp black, indicating the flow of air around the body.

As a result of these investigations, it was found that at 80 miles per hour 60.2 horsepower was required to overcome air resistance on the old Reo compared with 52.5 horsepower for the

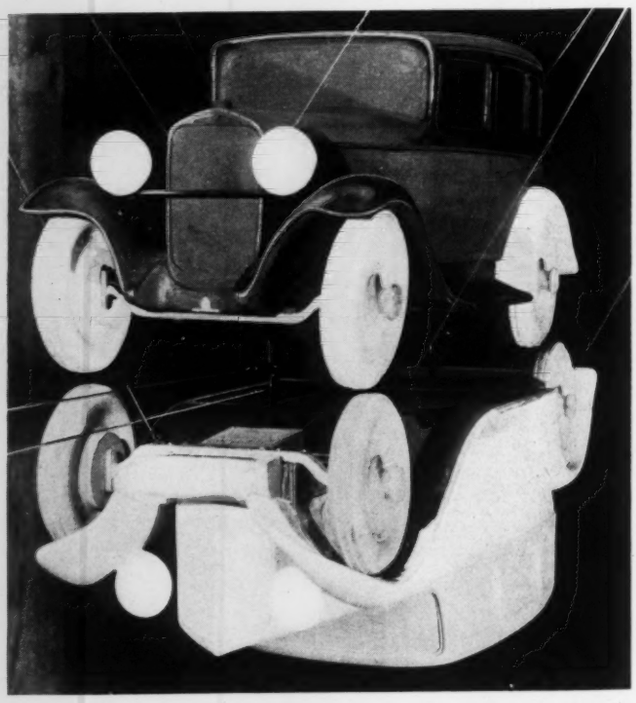


Fig. 2—Models of old and new Reo automobiles suspended in wind tunnel

new Reo-Royale. This reduction of 12.8 per cent in power requirements is an important factor in this day of higher speeds.

Of course attempts to reduce air resistance on automobiles are not new. Racing car bodies have been designed with that purpose in mind from the early days of the motor car. But in the Reo-Royale we see some of the influences which are reflected in the "mystery plane" made famous by the exploits of Capt. Frank Hawks. The venturi cowl over the motor blending into the fuselage and the streamlining of landing gear, tail skid and practically every other exposed part are important factors in increasing speed through reduction of resistance. Similar principles of design are to be found in Bluebird II, the 1450-horsepower racing car in which Capt. Malcolm Campbell hopes to break the late Major Segraves' record of 231.36 miles per hour at Daytona.

It will be interesting to watch the further migration of ideas originating from experience now being accumulated in practical applications of aerodynamics. Especially interesting will be the behavior of the tail stabilizing fin on Bluebird II. Will it help to prevent tragedies such as those that befell Lockhart and his Blackhawk, Bible and his Triplex and the leaping proclivities of Capt. Campbell's Bluebird I?

Tradition Affects Design Trends

IT IS surprising how loyalty to tradition affects design. This has been illustrated in every branch of engineering, but is especially evident in the comparatively young field of automotive construction.

A decade or more passed before the motor car threw off the influence of the horse-drawn carriage in the design and construction of bodies. Likewise, when sheet metal was introduced for body construction, it was mounted on a frame in much the same way that laminated wood had been applied in the early days of body design.

In this year's models, there is an indication that engineers are finding the frame members superfluous. Frameless all-metal bodies have been used successfully in Europe and it is believed they will appear on one or more American cars in the near future. Certainly the improvements in methods of fabricating sheet steel and aluminum make this a logical development.

And now the suggestion is made that the frame on tank trucks can be dispensed with. Since a tank of cylindrical, oval or rectangular section for gasoline, oil, milk or other liquids is structurally a strong and rigid beam, why not let it serve the purpose of a motor truck frame?

This idea is proposed by A. Ludlow Clayden in the Jan. 21 issue of *National Petroleum News*. He declares that in the tank truck of conventional design the frame and tank supports "are just so much wasted material; if only we were free to use the strength inherent in the tank itself."

The author suggests that there would be advantages in lowering the tank so that its under side is about 18 inches from the ground. However, a conventional rear truck axle could not be accommodated in such restricted space, and therefore some other arrangement would be necessary.

Mr. Clayden gives several proposals, such as front wheel drive, with dropped dead axles for the rear wheels. In this case the rear spring hangers would be attached to the tank itself. Another possible construction would be to build up a unit of "engine, transmission and driving axle with the engine transverse so that its length is parallel to the axle instead of at right angles to it. This unit would combine brakes and driving and it might be a four-wheel, double axle bogie without ability to be steered. A unit of this sort would go at the rear end of the

tank which would be recessed. The front axle would then be used only for steering."

It is interesting to note this trend of thinking in tank truck design because it corresponds so closely to the evolution of railroad tank car construction. At first tanks were simply mounted on flat cars. Then the floor was removed, leaving the tank on the frame. Next the flat car frame was discarded and a single box girder under the center of the tank sufficed. Even this member could be dispensed with if it were not for the abuse a car receives in handling when coupled with perhaps a hundred other cars in a train.

Hard-Facing Metals Increase Life

AMONG the interesting applications of hard-facing of metals described at a recent meeting of the New York section of the American Welding society was that for airplane tail skids. W. A. Wissler, Union Carbide & Carbon Research Laboratories, Inc., Long Island City, N. Y., and A. V. Harris, Haynes Stellite Co., New York, explained how the life of tail skids has been increased 20 times by hard-facing.

According to these speakers, the length of service varies greatly, depending upon the character of landing fields. Some fields are paved with decomposed granite, others with oiled cinders and still others with plain dirt. Reports from a western field, they reported, show that the average life of an ordinary skid on a granite faced field is about 40 landings. A skid made up with insets of tungsten carbide and faced with Haynes Stellite lasted approximately 800 landings.

Thus hard-facing, which has proved satisfactory for dies, tractor treads, grinder rings on cement mills, shovel dipper teeth, dredger parts, etc., now finds its way into the aeronautical field.

Save Space in Elevator System

INCREASING heights of buildings are accentuating the problem of vertical transportation. One of the solutions probably will be dual elevators—that is, two cars in a single shaft. The first installation of this kind has been completed by the Westinghouse Electric & Mfg. Co. in its main office building at East Pittsburgh, Pa.

H. D. James, consulting engineer for the Westinghouse Electric Elevator Co. comments on the features of an installation for a 20-story building as follows:

"The upper car of the two is the express car. It runs without stopping to floor 11 and serves floors from that point to the top. As soon as the express car is out of its way, the lower or local car, which has been waiting at the basement level, rises to the street level and then serves the lower 10 floors. The arrangement of cars is shown in Fig. 3.

"Car operation is so timed that both cars will normally reach their upper limits at about the same time, but if the express car arrives at its destination first it is held there until the local car completes its run and starts downward.

"Safety is insured by the use of three independent safety systems—one electrical and two mechanical. A signal system in the car informs the operator of his own position and that of the other car and also indicates what is happening should his car be automatically delayed or stopped."

Without going into detail, it may be said that this dual system involves a number of interesting mechanical problems, including arrangement of hoisting machines, hoisting cables and counterweights so that there is no interference. The electrical problems, while intricate, are not radically different from those in many other types of machinery where interlocking devices are employed to control the synchronized movements of multiple parts.

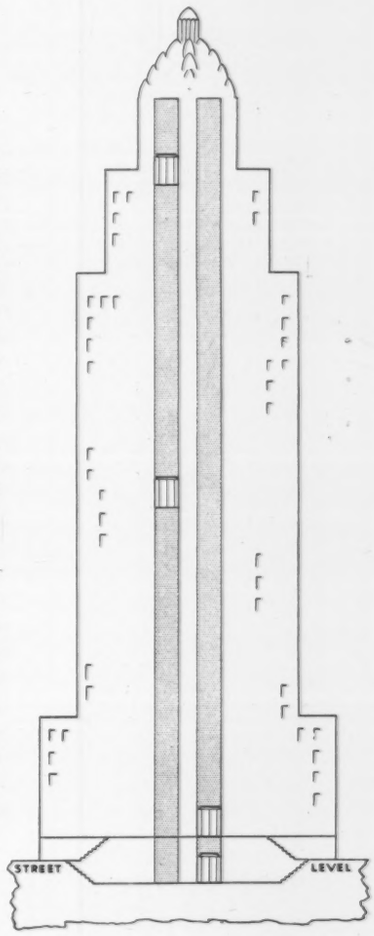


Fig. 3—Dual elevator system (two cars in single shaft) as Westinghouse engineers have designed it for modern office buildings. In the right shaft cars are at their lower positions, ready to ascend. In the left shaft, they are at their upper limits of travel and are ready to descend. Three safety systems—one electrical and two mechanical—are provided. The first installation of this type of elevator has been completed in the main office of the Westinghouse company

Experience gained in the development of interlocking block signals on railroads, synchronized stands in continuous rolling mills and nu-

merous similar applications of electrical control devices should be of value in working out problems of vertical transportation. Necessity of keeping the space devoted to elevators to a minimum undoubtedly will stimulate rapid development of the dual system, especially in buildings of 40 stories or more.

Style Plays Part in Fan Design

MANY of the products for home or office now being offered show the influence of the changing modes in interior decoration. An illustration is the new 8-inch oscillating fan introduced by Robbins & Myers, Inc., Springfield, O., as part of its 1931 line of desk, ceiling and

Fig. 4—Modernistic fan designed to harmonize with interior furnishings in modern home or office. Its appearance reflects the current trend in interior decoration

ventilating fans. As shown in Fig. 4, it has a smartly flared guard and beveled base, which with its shaded silver-like finish, give the fan an attractive appearance which harmonizes with modern interior furnishings. The oscillating mechanism mounted on the front of the fan between the motor and blades is masked and protected by the rigid guard.

The trend toward designs which reflect modern influences in art and architecture is responsible for the employment by a number of manufacturing companies of experts in the finish and appearance of household and office equipment. Style is a factor to be reckoned with by those whose products must harmonize with modern interior furnishings.

Economy in Expansion Joints

OCCASIONALLY designers are called upon to provide economical expansion joints in pressure vessels or pipe. This problem was encountered in constructing a mile-long vacuum tube near Santa Ana, Calif., for the use of Dr. A. A. Michelson in his studies of the travel of light.

The tube was made of 60-foot lengths of 36-inch corrugated pipe of No. 14 gage Armco sheets. A space of 1 inch was left between each 60-foot length of pipe. This space was covered by an 8-inch wide collar of strip metal which extended 3 ½ inches over the ends of each section of pipe. This band then was wrapped with canvas, after which a rubber covering—made by slitting the inner tube of an automobile tire—was placed over the canvas and metal slip joint. The ends of the rubber covering were fastened to the pipe with rubber cement and then wrapped securely with strong cord in the troughs of a pipe corrugation. Then the rubber was covered by waterproofed canvas, the edges of which were sealed to the pipe by several windings of friction tape. The entire exterior of the joint then was painted with a protective paint.

These joints have proved satisfactory in withstanding the pressure incurred in establishing a vacuum of 29 inches in the 3-foot tube, which is slightly more than a mile long.

Design Embodies Standard Shapes

STANDARD plates and shapes, used as a built up frame, in combination with standard parts form the basic elements in the design of a special air-operated piercing press now being manufactured by the Hannifin Mfg. Co., Chicago. The press, shown in the accompanying illustration was built entirely of standard plates

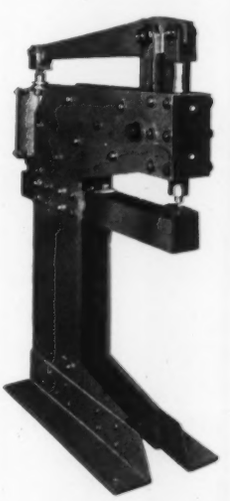


Fig. 5—Standard plates and shapes were employed in this air-operated piercing press. It is assembled with standard bolts and nuts, but future design provides for welding

and shapes assembled with standard bolts and nuts. It will be used for punching 1-5/16-inch holes in cylindrical copper boiler shells. The frame sides are of flat stock cut to shape with a torch while standard channel sections are used as spacers. Future design includes the electric welding of the assembly wherever possible. The air cylinders, valves, and similar parts are identical with parts used on the company's standard models. The air cylinder is the only portion of the machine that is not constructed of standard material.

On What Test Value Should Working Stress Be Based?

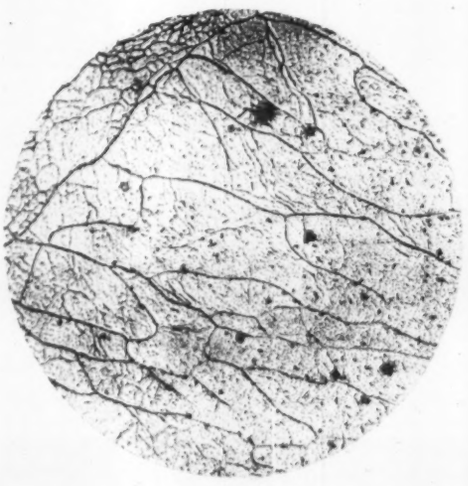
"ENGINEERS in charge of design should consider the strength of a machine part not merely from the viewpoint of one kind of strength but from the viewpoint of each kind of failure which possibly may occur."—The author.

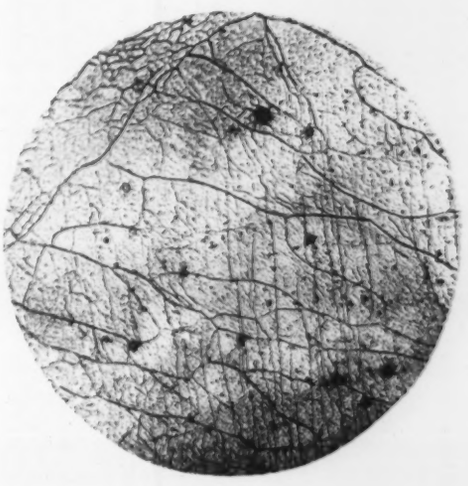
By H. F. Moore
Research Professor of Engineering Materials, University of Illinois

THE task of the engineer responsible for design in selecting allowable working stresses for machine parts is a difficult one. While the formulas which he uses to compute the probable stresses under service conditions are mathematical in their nature, the choice of a suitable working stress must be determined either from the result of long experience with a particular kind of service and a particular class of materials, or it must be based on the results of laboratory tests of specimens of material, tests which never simulate working conditions exactly.

Within the last two decades many new materials have become available for which it is impossible to depend upon experience in selecting safe working stresses. For example, many of the fine alloy steels show test results indicating far greater strength than the ordinary machinery steels of 20 years ago. However, the designer must remember that this greater strength is obtained only by careful heat treatment, and moreover he must remember that the fine alloy steels are more sensitive to damage by grooves, drilled holes, screw threads and the like than is ordinary plain carbon machine steel. We have not as yet accumulated enough practical experience with these materials to serve satisfactorily as the sole basis for determining working stresses, and we must depend on test results.

ULTIMATE TENSILE STRENGTH AS CRITERION: The oldest criterion of strength for working stresses in a metal is the ultimate tensile strength. This has been used widely in spite of the fact that it is realized serious damage is done to a machine part by stresses far below the ultimate tensile strength. It has been serviceable on account of the fact that for boiler plate steel, ordinary machine steel and structural steel, both the elastic strength and the strength under repeated stress have a fairly constant ratio to this tensile strength. However, when we come to consider heat treated alloy steels, brass bronze, aluminum, aluminum alloys and copper-nickel alloys these ratios are found to be widely different and the tensile strength becomes markedly less reliable as a general criterion on which to





Photomicrographs showing spread of "fatigue" cracks under repeated stress. Fig. 1—(left)—Surface of unstressed iron. Magnification is about 100 times and crystalline grains of iron are shown. Fig. 2—(Right)—Same region after it had been subjected to several hundred reversals of bending stress. Note cracks across the crystalline grains

base working stress than was the case 20 years ago.

ELASTIC LIMIT AND YIELD POINT: One of the outstanding facts which becomes evident to the most casual student of a history of mechanics of materials is that the whole science has developed around low carbon steel as the typical material. Among other properties low carbon steel has a sharply marked limiting stress below which the action of the material is almost perfectly elastic, and above which it is highly plastic—it has a well defined yield point. For higher carbon steels, cast iron, heat treated alloy steels, nonferrous metals and nonmetals this limiting stress is much less well marked.

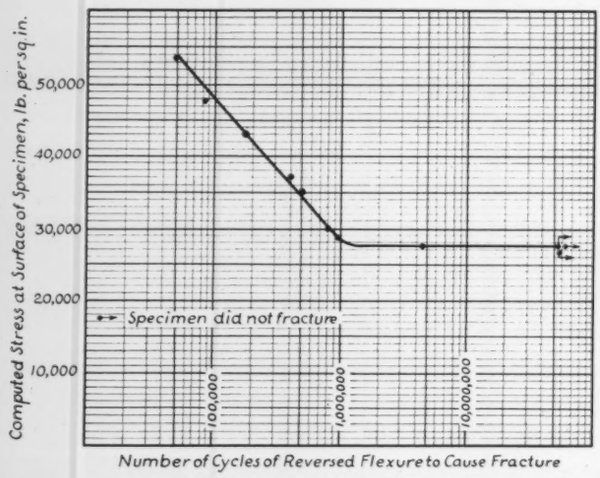


Fig. 3—Results of fatigue tests of .20 per cent carbon steel, as rolled, under reversed flexure

By using delicate strain measuring instruments testing engineers have built up a rather elaborate ritual of determining with a high degree of precision the limiting stress which marks the beginning of plastic action. To this limiting stress, thus delicately determined, the name "elastic limit" has been given and there has grown up an idea—almost a superstition—that for each metal there is a well defined limiting stress below which the action is perfectly elastic and below which loading may be repeated an indefinitely large number of times without failure. The whole trend of recent experimentation tends to throw doubt upon any such *absolute* "elastic limit." Nevertheless, an arbitrarily determined limiting stress marking a division between a state of nearly perfect elasticity and one characterized by appreciable plastic action is an important criterion of strength, especially for parts subjected to loads repeated but a few times.

Unfortunately test methods in use in different testing laboratories vary greatly and with them vary values determined for "elastic limit." Today it frequently would be difficult to evaluate the relative elastic strength of two metals tested in different laboratories. It is to be hoped that in the near future standard methods of determining elastic strength will come into general use. Elastic strength, or yield strength, (as it is proposed to call it) is especially important to the structural engineer. It is, however, of no small importance to the machine designer. Certainly his machines cannot work properly if the parts suffer appreciable distortion, and he must consider some limiting stress as *one* criterion of strength,—a criterion for safety against failure by plastic distortion.

FATIGUE LIMIT AS A CRITERION: As the use of high speed machinery has developed, it has been evident that fracture of machine parts sometimes takes place under stresses not only lower than the tensile strength, but lower than the elastic limit as determined by ordinary tests. For a long time it was thought that if the stress was below the "true" elastic limit such fracture would not occur, but recent studies indicate that such fracture is quite different in its nature from plastic action, and that it consists of a spreading crack in the material.

At present the best criterion for strength to resist repeated stress is the endurance limit, or fatigue limit, which is determined by tests of a number of specimens under cycles of repeated stress of various intensities. A curve plotted with stresses as ordinates and number of cycles to cause fracture as abscissas tends to become horizontal at some fairly well defined stress. Such a curve is shown in Fig. 3 and for the material shown in that figure the limiting stress below which this spreading crack will not occur is in the vicinity of 27,500 pounds per square inch. This limiting stress is known as the fatigue limit, or the endurance limit.

Accelerated Tests Not Reliable

Determination of fatigue limit or endurance limit is a time consuming and costly test process. Usually at least six specimens are required, and for the longest test of an individual specimen about five days is required. For nonferrous metals this maximum period may be much longer. Various accelerated tests have been proposed to determine the endurance limit, but so far none of them have proved reliable. Especially unreliable is the attempt to determine fatigue strength from the length of time required to cause failure under cycles of some "standard" stress *above* the endurance limit. The results obtained for this kind of a test arrange the different metals in different orders of merit depending on the "standard" stress arbitrarily chosen.

The question of fatigue strength is complicated by the fact that a comparatively few cycles of overstress may start a crack. and that this crack will spread to complete failure under stresses possibly as low as half those required to start it. A second complicating factor is the

fact that under cycles of stress *below* the endurance limit the fatigue strength of many metals is increased, probably due to localized cold working. A third complicating factor lies in the differing sensitivity of metals to damage by notches, sharp shoulders, and other stress-raising changes of outline. In general, the higher strength metals are more damaged by such "stress raisers" than are the lower strength metals.

In this connection it should be noted that our knowledge of the effect of sudden changes of outline on localized stress is slight. Mathematical analysis can be used only for a few cases of localized stress; for example, there is no mathematical analysis developed for the localized stress at the root of a screw thread. The whole subject of the valuation and significance of localized stress furnishes a most fruitful field for research by the machine designer.

SIGNIFICANCE OF DUCTILITY: There is a common idea among designers that ductile material stands repeated stress and shock better than brittle material. It is true that ductile material can absorb a vastly greater amount of energy before final fracture occurs than is the case for brittle material. It also is true that for exceedingly heavy overload ductile material would stand up under a longer period of abuse than would brittle. However, as the stress approaches working stress in value the significance of ductility becomes less and less. A good example of this is seen in the case of springs, which usually are made of a strong, brittle steel, and for which strength and not ductility is the prime requisite.

Ductility in a metal is valuable not as a factor contributing directly to strength, but as an insurance factor against damage due to a few occasional overloadings, or against sudden shattering fracture under a destructive overload.

CREEP LIMIT AS A CRITERION: The latest candidate for a position as a criterion of strength is the creep limit. For ordinary structural metals this limit is of significance only at high temperatures, but metals which can carry stress at high temperatures are coming more and more into demand year by year.

Creep of a metal resembles plastic action in that it causes permanent distortion, but differs from it in that once started under a load it is continuous, and so far as we know, continues as long as the load is on the piece. The careful study of this creep limit is a recent development in the materials testing world. At the present time it is not possible to state whether there is any limit below which creep will not take place, but it is possible to determine for any metal at any temperature a stress below which creep will not exceed any given rate.

CORROSION FATIGUE LIMIT: Failure of metal parts by ordinary corrosion is a more common problem with the structural engineer than the machine designer. However, the recent work of McAdam has shown that under the simultaneous action of repeated stress and a mild corroding medium fatigue failure may start at stresses far below the ordinary fatigue limit. Furthermore the advantage in strength of many of the heat treated alloy steels disappears if corroding action and repeated stress act simultaneously.

So serious is this action that it seems difficult to locate the lowest stress at which corrosion-fatigue may start a destructive crack. Where corrosion is not present the rate of application of cycles of stress does not seem to produce much effect on fatigue limit, but where corrosion *is* present a slow rate of application of cycles of stress is more destructive than a rapid. At present the most hopeful way of treating corrosion-fatigue problems seems to be the prevention of corrosion-fatigue by the use of paints, enamels or plating with noncorrosive metals, or other protective coatings, or the use of corrosion resistant metal. This problem is one on which further investigation is needed sorely at the present time.

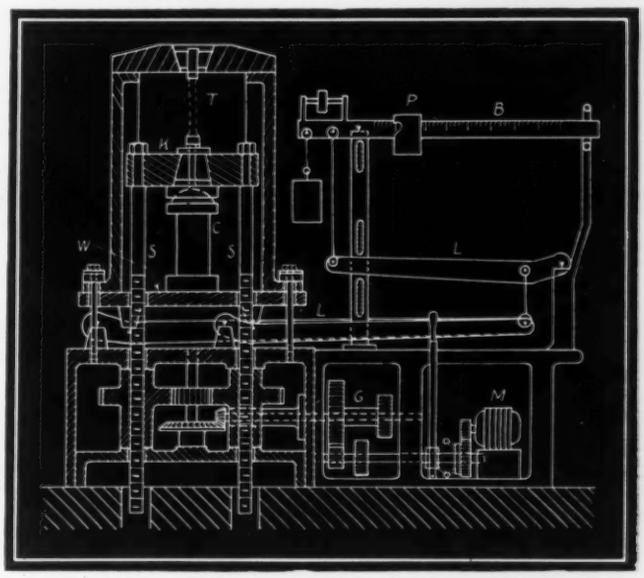


Fig. 4—Diagram of screw power, balance beam type of testing machine

Power from motor M transmitted through speed-reducing gears G and screws S to crosshead K. The crosshead transmits force through test specimen (C for compression specimen, in solid lines, or T for tension specimen shown dotted) to weighing table W which rests on knife edge bearings of weighing lever system L. This system is balanced by sliding the poise P along beam B and thus the force on specimen is weighed

FRACTURE UNDER SUDDEN LOAD (IMPACT): The word "impact" has been a mystery word in the language of the materials testing engineer. Parts which have failed, and for whose failure no cause could be discovered, were said to have failed by "impact" if they were subjected to any

amount of jolting or jarring received in service.

For parts in nearly all machines, the writer cannot see that the jolts and jars of service produce any mysterious kind of action. When a load is applied to a member it must be applied with a certain amount of velocity else application never can be accomplished. This means that in addition to the stresses caused by weights of parts and external forces acting on them there are forces due to the inertia of the parts. However, this action does not bring in anything mysterious or anything outside the ordinary laws of mechanics, unless the load is applied much more rapidly than is the case of automobile parts.

In testing-machine tests of material and in the application of loads which remain steady the inertia feature is negligible. In cases where the inertia feature is not negligible it usually is more feasible to compute the *energy* which can be absorbed before fracture than it is to compute *force* developed.

There has been a widespread use of impact tests on notched bars of metals, and it is rather generally assumed that the results of these tests indicate the resistance of a metal to "shock." In this connection attention should be called to the fact that the results of these impacts are measured in energy whereas the results in ordinary tests are measured in stress. Therefore there can be no direct comparison between the results of the tests. Moreover, the careful tests of Petrenko at the bureau of standards indicate that the same general information about a material as that given by "impact" tests of notched specimens can be obtained by tests of notched specimens under slowly applied loads if the energy is determined by measuring the area under a load-deflection diagram.

The significance of the notched bar test is not very clear but it seems to have more to do with the effect of a notch on the metal than it does with the ability of metal to resist shock.

No Single Criterion Covers All Cases

FACTOR OF SAFETY: The traditional factor of safety for the machine designer is that number by which the ultimate tensile strength is divided to give allowable working stress. Today it is evident that neither the ultimate tensile strength nor any other *single* criterion can be used as the basis for figuring working stress for all cases. With our present knowledge it frequently will be necessary to make two or three different estimates of working stress, based on as many different criteria, and using the criterion that gives us the lowest stress. For example, it often is necessary to compute the possibilities of failure by plastic yielding and also to compute the danger of failure by fracture under repeated stress. The criterion for failure by slip would be some limiting yield strength—some "elastic limit"—while the criterion for failure under stress would be the endurance limit.

It also is obvious that the ratio of working stress to ultimate stress would be different not only for different types of service but also for different types of failure. It would seem that any "factor of safety" (better called "factor of uncertainty") may be broken up into at least three parts: (1) The factor of uncertainty of load to be carried, (2) The factor of uncertainty as to stress developed by a given load,* and (3) The uncertainty as to the uniformity, reliability and strength of the material to stand a given type of load. The first of these items will involve questions of the seriousness of a failure, danger of loss of life, and experience with the vagaries of service loading. The second item usually is neglected, although it is becoming more and more evident that all our mathematical formulas for strength of materials are safe "statistical" guides rather than precise formulas. The third item would vary with the kind of failure feared, and the resulting criterion (or criteria) of strength chosen.

Slip Factor Based on Yield Strength

For this third item a factor of safety against *slip*, or failure by plastic action would be based on the yield strength, and would not have to be high, perhaps under favorable circumstances not greater than 1.5, ** except in the case of compression failure of a strut for which slip is apt to be followed by disastrous collapse of the whole member, in which case the factor should be higher, probably not less than 2.5. With this exception slip does not involve destructive collapse, usually giving warning before serious damage is done. The same remark would apply to failure by flow, and probably with even greater force. On the other hand failure by fracture, especially under repeated stress, is apt to come without warning and its results may be disastrous. It would seem that a higher factor, say a factor not less than 2.5*** should be used here. For fracture under repeated stress this factor would be based on the endurance limit.

The quantitative values given in this article are suggestive and should not be accepted for any given case without close examination of that case. However, the fundamental idea that machine parts may fail structurally in three or four different ways is the main thesis of this article, together with the admonition that designers look at the strength of a machine part not merely from the viewpoint of *one* kind of strength but from the viewpoint of *each* kind of failure which possibly may occur.

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*All our common stress formulas are "statistical" approximations rather than precise statements of fact.

**It must be remembered that this value is for the third item only; another factor of at least 1.5 should be allowed for item (1), making the total factor 2.25 or more.

***See preceding footnote.

Using Splines in Governors

By Harold F. Shepherd

MOST of the elementary mechanisms used by man in assembling his machines were isolated and classified long ago by early searchers into "Natural Philosophy." We use them by design but occasionally one of them appears adventitiously, as a "stow-away."

A case of this nature has been uncovered in engine governor design. An elementary "ratchet" or "clamp" of small but relatively significant effect often is to be recognized in the linkage and sleeve.

If the structure in Fig. 1 were a rigid one, that is, if the sleeve *A* were forced on the spindle *B*, and the pintles *C*, *C'*, and *C''* were driven home it would be possible to balance the assembly statically and dynamically about its axis of rotation *XX*. But all pivots and sliding fits in governors require at least enough freedom to permit the building up of the oil film of minimum resistance. This freedom is increased by the necessary tolerances of manufacturing and by wear so that the statically or dynamically balanced device is free to assume one of two unbalanced positions, the weights running in different orbits as shown much exaggerated in the sketch. One or the other of these positions we find will be sustained in operation.

Weights Exert Different Forces

This results in a greater centrifugal force being produced by one weight *P* than the other *P'*. The springs *F* exert equal centripetal force on both weights. Therefore the weight having the major orbit, finding its centripetal force insufficient, tends to lift the sleeve while the excessive centripetal force acting on the other weight tends to reduce its orbit and to depress the sleeve.

Under the influence of this couple the sleeve cocks and carries the unbalanced load in tension between the bearing points assumed to be at the edges *b* and *b'*. If *f* or *f'* represents the unbalanced load at either side, *p* or *p'* may represent its horizontal component and $p + p'$ multiplied by the coefficient of friction measures the effort required to move the governor from its equilibrium position when a change of speed makes it necessary for the governor to function.

If the spindle is large and the sleeve relatively short, this clamping action will undoubtedly exert a ruinous influence on governing action.

It is desirable to keep the sleeve short and a stiff spindle also is a requirement, but splining the shaft and broaching the sleeve as shown in the section offers a satisfactory solution. In this case the width of the splines relative to the sleeve length rather than the spindle diameter and sleeve length determines the friction to be overcome before the governor can function.

The splined sleeve has improved governors having every other refinement known to the art including antifriction bearings on all pivots and spring loading so arranged as to impose no reactions on the mechanism.

It is quite usual to fit a single key spline to the governor sleeve to prevent twisting of the linkage under the drag of collar *D*. This however does not suffice, multiple splines being effective in all directions as is necessary if the sleeve is to slide with minimum friction under tipping loads.

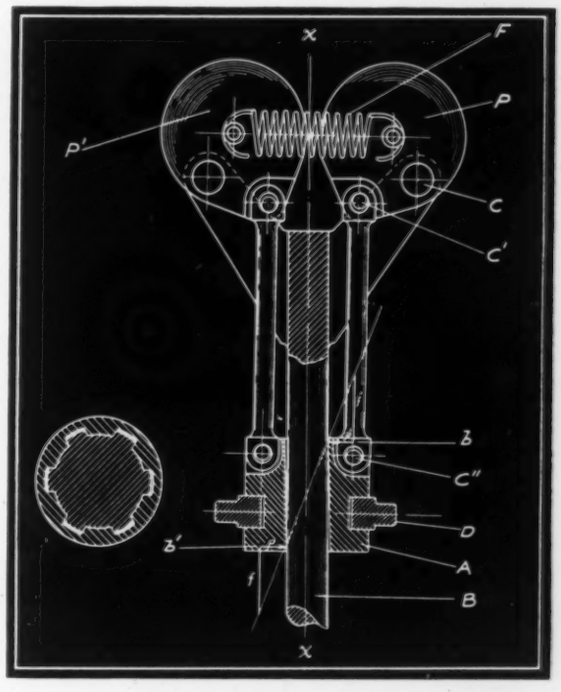


Fig. 1—Cross section of governor showing how unbalance of mechanism and also locking of sleeve can be caused by spindle and pin clearances

Less Space—
More Capacity
in
Air Conditioning Equipment

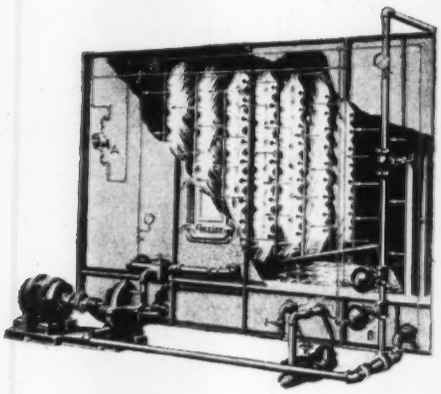


Fig. 1—Cutaway section of air washer

By L. B. Mumma

RECENT trends in development of air conditioning equipment are toward more compact units and a shifting to more durable materials. All welded construction and remote control are the latest design practice. Compactness opens a new field to air conditioning machinery in the office, store and small factory. Reduction in unit size also induces portability, which is desirable for office rearrangement or removal.

Apart from the foregoing features there are a number of other details involved in the design of air conditioning equipment which are of interest to engineers in charge of design. It is proposed to refer more particularly in the following to those items and ideas having application in other fields.

In the standard air washer, Fig. 1, the casing and eliminator plates usually are made of copper or "Toncan" metal, an alloy of copper and molybdenum with open hearth iron. The framework and the water reservoir are of welded construction replacing a riveted or bolted and soldered job. To eliminate vibration in the long casings, angle iron stiffeners are welded about two feet apart, vertically along the casing length. Noise which is apt to be caused by eddy currents within the washer also is reduced by this method.

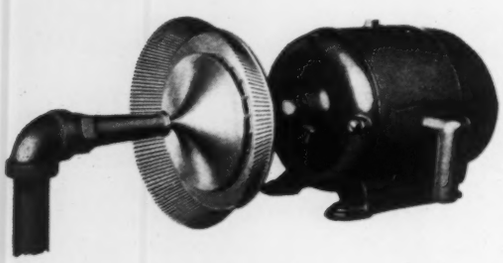


Fig. 2—This atomizer distributes the spray in a definite plane, permitting reduction in length of air travel

Two Types of Nozzles Employed

Spray nozzles formerly were made of brass or monel metal, but stainless steel now is being used to a large extent for these parts. Employment of these metals is necessary to prevent corrosion and eliminate nozzle stoppage troubles. The nozzles are of two types. In one type the water is delivered tangentially and perpendicular to the orifice. This gives the water a whirling motion within the head, thus causing it literally to explode through the orifice into an atomized spray. The other type of nozzle is designed with an inner casting, with grooves cut on the circumference. Water must follow these grooves to reach the orifice and in so doing is whirled within the head. This nozzle also produces a satisfactory mist. Control on these units usually is obtained by a thermostat set in the air delivery duct and operating either the by-pass dampers or the steam or refrigerant supply valve.

An efficient and novel method of producing

the spray is found in the Bayley Turbo atomizer shown in Fig. 2. In this device the water is delivered to the spray unit in a solid stream of fairly large diameter. Clogging of the lines and pipes is entirely eliminated. Leaving the large supply nozzle, the water diffuses evenly over the surface of a dished cone. Air is drawn into the cone through slots near the center and mixes with the water just before it reaches the atomizing pins, where it is churned into a fine mist and distributed evenly throughout the washing chamber. Due to this effective spray distribution in a definite plane, the length of air travel in the washer is reduced, thus making for compactness. The motor is attached directly to the atomizing unit, this being keyed to the motor shaft. On account of the presence of water and spray a fully enclosed marine type motor is employed.

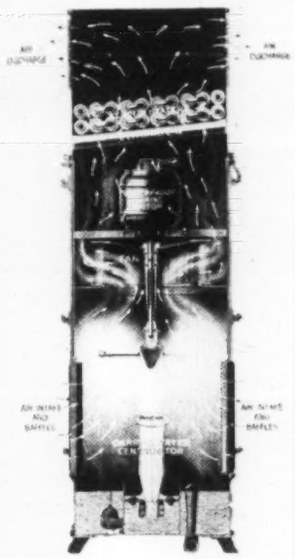


Fig. 3 — Portability and reduction of floor space have been given full consideration in development of this unit. Water is drawn up through center tube and sprayed from ends of rotating pipes. Note the flexible steel coupling between motor and tube

One big advantage of this atomizing unit is that it takes considerably less horsepower. This is due to the reduced pressure necessary at the single nozzle and also to the decreased amount of water required to create a complete sheet of mist across the washer area. The dished cone and the atomizing pins are made of bronze to obviate the effect of corrosion.

Casing Length Is Reduced

To overcome the long length of the standard washer casing, the Sturtevant Co. has developed the "Filticooler," shown in Fig. 4. By use of this equipment the same result is obtained in 28 inches as was accomplished formerly in ten feet. This was made possible by three changes; first, the spray nozzles were reversed to deliver the water against the air flow; second, entering air is broken up into small streams by a filter which is kept flooded; another filter of the same type is placed at the air outlet to again insure constant velocity over the area; third, the spray nozzles have been redesigned to give a more complete mist. This unit will deliver 100 per cent saturated air with one bank of spray nozzles, a feat which has not been achieved heretofore with less than two banks of stationary nozzles in series.

A disadvantage in the unit is the increase in power necessary to force the air through the unit. This is not excessive but has nearly twice the friction loss as through a standard washer. The filters are responsible for a large part of this increase in friction. However, the decrease in length makes up for the extra friction incurred. Noise and vibration are eliminated because the velocity through the unit is low.

Water Discharged in Dense Spray

Another interesting development in unit air conditioning plants is the Carrier air conditioner. For the floor space occupied, it has a high capacity. Portability has been a prime requirement in the design. Looking at the unit in section, Fig. 3, we see the water reservoir at the bottom. From the reservoir, the Carrier "Centrijector," a novel device, draws water up through the tube and discharges it in a dense spray through nozzles at the end of pipes attached radially to the revolving centrijector. The centrijector is a hollow tube of smaller cross-section at the bottom than at the body. Centrifugal action produced by rotation draws the water up into the tube, and it then is ejected from the nozzles by pressure produced by the

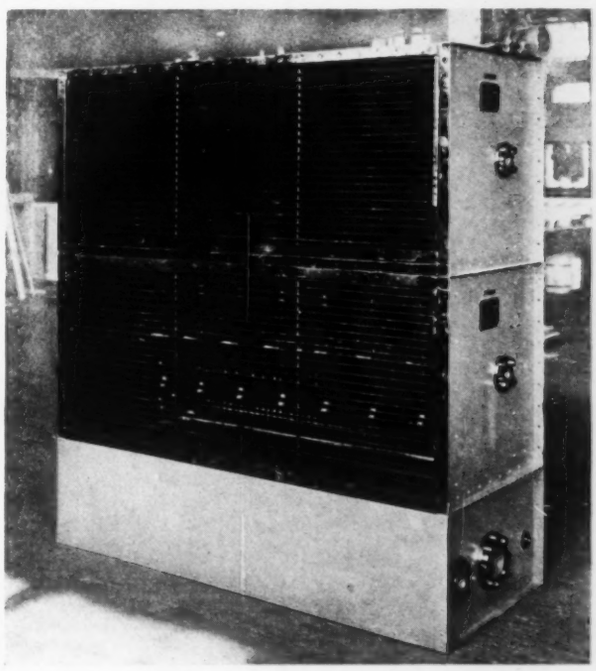


Fig. 4—Another modern washer developed to overcome the disadvantages of bulky equipment

rotating action of the radial pipes.

These nozzles discharge the water at right angles to the pipes and backward, that is, contrary to the direction of rotation. Herein, ingenious advantage is taken of a familiar phenomenon. The reaction of the discharging water serves to drive the rotating pipes forward, much as a revolving water sprinkler, thus recovering an appreciable percentage of the power expended in rotation. The result is a spray system using from one-seventh to one-third the power required by centrifugal pumps of various efficiencies, delivering the same quantity of water at the same pressure to stationary spray nozzles. The centrijector sprays 27 gallons of water per minute at a pressure at the nozzles of forty pounds per square inch with a measured power consumption of four-tenths horsepower. With a one horsepower motor the unit has a capacity of 2500 cubic feet of conditioned air per minute.

Motor of Special Design Is Used

The motor for driving the fan, located directly above the centrijector, is of special design. It is totally enclosed to prevent the entry of moisture, and as an additional precaution the windings are moisture proofed by special impregnation. The motor shaft is of corrosion-resisting nickel steel operating on ball bearings. Lubrication is provided through two grease cups.

Absolute assurance against vibration is provided by the self-aligning features of the centrijector. It is connected to the motor through the fan above by a rustless steel flexible coupling carried in a safety sleeve. This limits the deflection and yet allows the small shaft to seek its own center of rotation. At the bottom of the centrijector tube a self-aligning oilless bearing has been placed, supported by rubber rings.

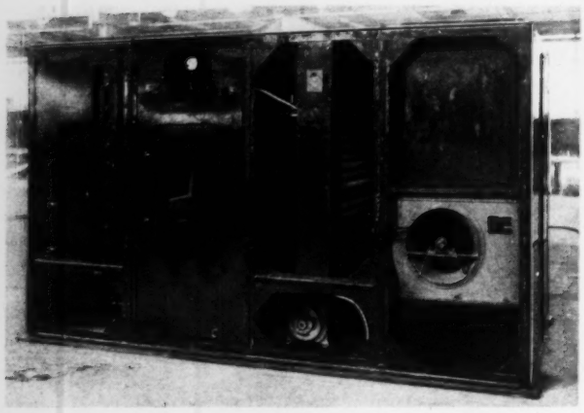


Fig. 5—Asbestos board is used in this larger unit to deaden the noise set up by air currents

This unit is compact, measuring 30 x 32 inches with a height of 7 feet 8 inches. It is finished in green enamel to match the customary office equipment.

In Fig. 5 is shown another recent development, of larger capacity. This unit has an overall length of eleven feet four inches, a height of six and a half feet, and width of six feet two inches. It will condition 10,000 cubic feet of air per minute. The construction is an all welded job using black iron sheets which are fully enameled after assembly. From the section of the unit in Fig. 6 it will be seen that the placing of pumps, motors and fan is such as to utilize the waste space and reduce overall dimensions as much as possible. The fan is driven by a Texrope drive, this being selected for quiet and smooth running. Due to the high velocities used, asbestos board is employed freely to absorb the roar and whistles accompanying the air currents. The inlet and outlet both are treated with this material. Though the unit seemingly is bulkly, it is quite portable. The control usually is remote in position with respect to the unit location. In this way the most important point will have the thermostat located near it, whereas the conditioner may be some distance away.

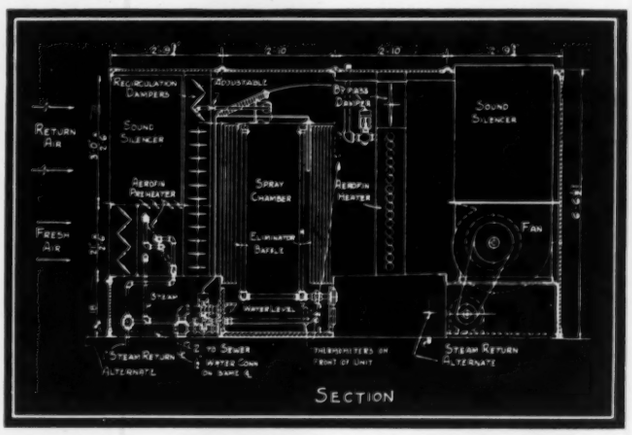


Fig. 6—Section of equipment in Fig. 5 showing utilization of space in mounting of mechanical units

Most of the remote control used on this type of apparatus has been developed to use air pressure as the operating force but lately there is a shifting to electrical operation. Air always has given a rather snappy action in controlling the temperatures or dampers but the electrical method has a more gradual movement until the balance position is attained. Longer distances between the conditioners and the hygrostat thus are available with electrical control.

Battelle Memorial Institute, Columbus, O., recently announced the establishment of two research projects sponsored by Ohio Steel Foundry Co. and the Ironsides Co., respectively. The former will cover development of steel foundry practice and the latter will deal with a study of special lubricants.

Systematizing Calculations in Design of Clutch and Brake Bands

By M. G. Van Voorhis

DESIGN of brake and clutch bands involves a series of mathematical operations which are not difficult to handle. Like so many of the design formulas, however, they require much of the trial and error procedure to obtain a desirable balance of dimensions or perhaps the best compromise. Those who work often with this type of design may have a system of procedure which simplifies the gathering and assembling of data. The purpose of this article will be to lay out a convenient system aided by charts to reduce the tedious process of making repeated computations. A few of the outstanding obstacles in the path of the designer will be mentioned, sufficient to give an idea of the application of general formulas, and the extent of their dependability and value.

A number of factors enter into the design of bands, some of which do not yield to mathematical treatment and others which are subject to errors due to uncontrollable conditions. Into this latter class falls the coefficient of friction between the lining and the drum for the reason that it depends upon the finish, lubrication, relative velocity, and even the temperature to which the rubbing surfaces are raised. This factor is named in particular because it is necessary to use it and assume a constant value for it in spite of the variability. The first group of factors requiring mathematical attention are contained in two formulas:

$$T - t = L/R \qquad \text{and} \qquad T/t = e^{u\theta}$$

in which, T = tension or compression at the tight end of the band in pounds

t = tension or compression in pounds at the slack end of the band

e = 2.71828 = base of natural logarithms

u = coefficient of friction between lining and drum

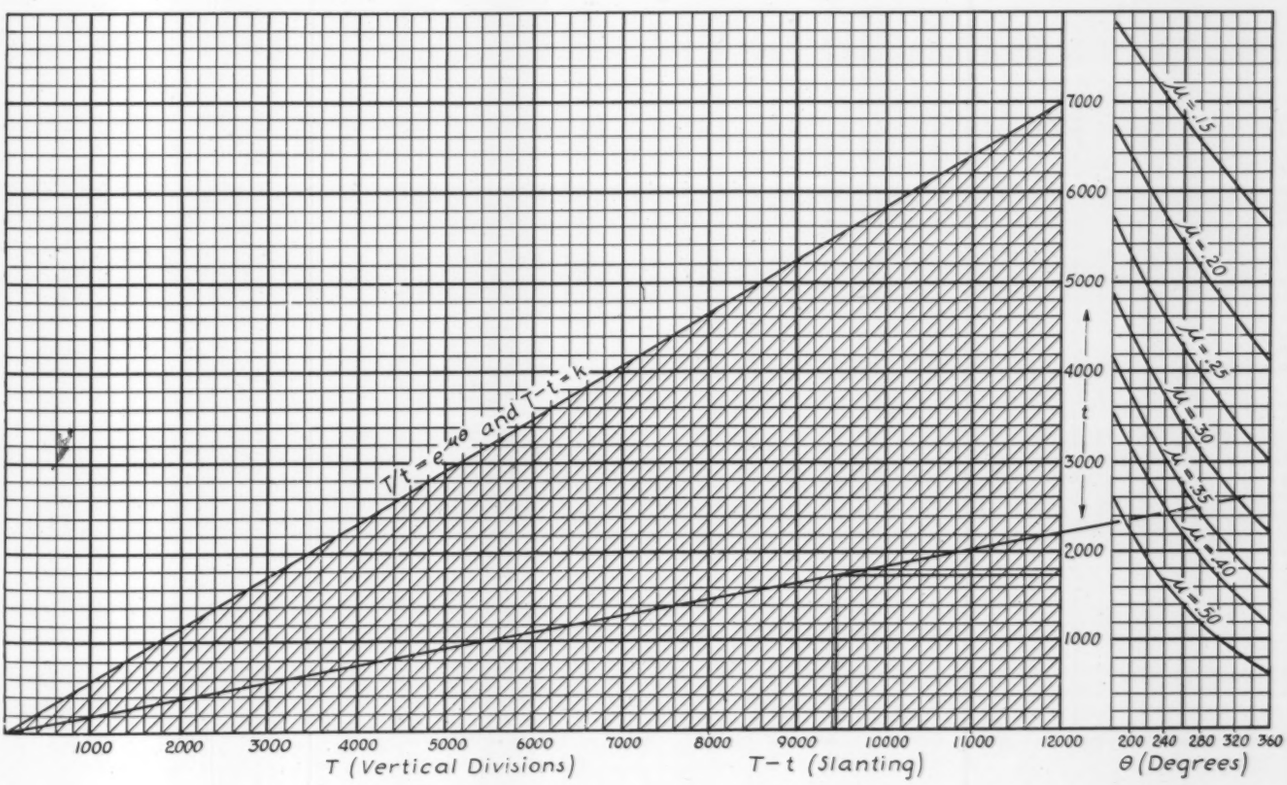


Fig. 1—Chart for determining the tension or compression at tight and slack end of band

θ = angle of wrap in radian measure
(If in degrees, multiply by .017453)

L = shaft torque in inch pounds

R = drum radius in inches

The derivation of the second formula is interesting and simple enough with a little calculus. Total frictional resistance is the summation of up' where p' is the band pressure at

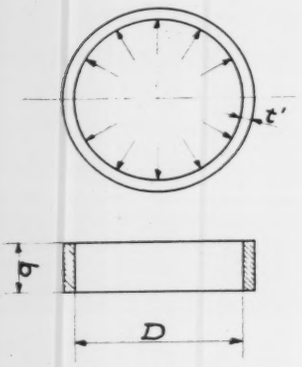


Fig. 2 — Stresses which occur due to pressure of lining against the drum are similar to those encountered in hollow cylinder

any point on the arc of contact. This may be expressed mathematically as

$$T - t = \Sigma up'$$

At a point on the arc of contact, the tension in one direction is practically equal to that in the opposite direction. These tensions will be represented by T_1 and T_2, their mean value by T', and their difference by an infinitesimal, $\Delta T'$ The angle by which the two tensions deviate from a straight line also is an infinitesimal, $\Delta\theta$. By the ordinary laws of vectorial forces,

$$p' = 2T' \sin \frac{\Delta\theta}{2}$$

But for very small angles, the angle may be substituted for its sine and

$$p' = T'\Delta\theta$$
$$up' = uT'\Delta\theta = T_1 - T_2 = \Delta T'$$

In the limit

$$uT'\, d\theta = dT'$$
$$\frac{dT'}{T'} = u\, d\theta$$
$$\int_t^T \frac{dT'}{T'} = u \int_0^\theta d\theta$$
$$Log_e T - log_e t = log_e T/t = u\theta$$
$$T/t = e^{u\theta}$$

It should be noted that the definitions of T and t are stated in such a way that they may be used without confusion with either inside or outside bands. In the first equation, the shaft torque must be known or assumed before starting the design. When the band is to be used in a clutch, it is required to absorb the maximum power of the engine or motor, or when used as a brake, to overcome the inertia of the load. This latter may be estimated from the kinetic energies of the moving masses of parts and loads using the well known formula, $E = Mv^2/2g$.

The solution of the above equations requires that some values are assumed which will satisfy space requirements or serve until closer estimates can be made. As an example, let it be assumed that 10 inches is the radius of an inside band clutch drum on which the engine supplies a shaft torque of 77300 inch pounds. Then $T—t = 7730$ pounds. Also, let $u = 0.3$ and $\theta = 325$ degrees.

This particular example is solved on the chart in Fig. 1 by a line drawn from the point ($u = .3$, $\theta = 325$) through the origin (O,O) of the T and t axes. This line intersects the diagonal scale of $T—t$ at 7730 from which the values of T and t are read:

$$T = 9460 \quad \text{and} \quad t = 1730$$

In this connection it is worth noting that the chart has a further convenience. Should the scales of T, t, and $T—t$ be of too great magnitude, simply divide them by ten for a low range.

These values provide the starting point of an analysis of stresses in the clutch parts as well as the band but since there are yet several considerations in the band we will proceed with the next step, which is to find the necessary cross-sectional dimensions of the band. The values of unit stress used may vary among manufacturers' standards but a safe range is from 15000 to 20000 pounds per square inch for bar steel with a factor of safety ranging from two to two and a half.

Usually the lining rivets are of brass and not more than one hole in any one section but this is of minor importance and needs consideration only on inside bands which are under compressive stresses, since the holes in the band ends are filled with steel rivets and have the same compressive strength as the band itself. When the band has tensile stresses exerted upon it, the weakest section is transferred to the riveted end which holds the load. In either case the area of cross-section should be equal to T divided by the allowable unit stress, plus the area of the rivet holes in the weakest section. This area is, of course, the diameter of the hole times the thickness of the band. Although the thickness may not yet have been settled, a rough estimate makes very small error.

In order to find the width (b) for best service, either the average or maximum pressure of the lining against the drum should be known. Average pressure usually is used for lining recommendations but since maximum pressure has been found to be in the neighborhood of double the average pressure (although pressures do not vary in proportion to the distance from the band end nor do they vary from zero to maximum)

and since the formula for maximum pressures can be solved more quickly, it is the more convenient to use. This pressure will occur at that end of the band which carries the total load.

The stresses which exist within the band are similar to those encountered in a hollow cylinder. If P is the pressure on the surface at any point, in pounds per square inch, the pressure on the semicircular surface is $P \times b \times \pi D/2$. The resultant pressure on a surface joining the ends of the semicircle is PDb, since Db is the area of the projection of the curved surface upon the plane. There is an equal pressure in the opposite direction upon the curved surface opposite. These two equal and opposite forces are resisted by the circumferential tensile or compressive stresses in the sections joining the two semicircles. If t' is the thickness of the wall of cylinder, the area of tension or compression is $2t'b$,

$$2t'bs = PDb$$

$$P = \frac{2t's}{D} = \frac{t's}{R}$$

Substitute for s (unit stress)

$$s = \frac{T'}{t'b}$$

Then

$$P = \frac{T'}{Rb}$$

and P is maximum when $T' = T$ (T' = mean tension or compression of any point.)

Another method of arriving at this formula may be clearer to some. It follows from an equation used previously in the development of the formula for the ratio, T/t:

$$p' = T'\Delta\theta$$

p' is an infinitesimal and more properly called $\Delta p'$. Its unit is pounds. P is the pressure in pounds per square inch and is equal to $\Delta p'/\Delta A$. Substituting for p' above:

$$P\Delta A = T'\Delta\theta$$

But

$$\Delta A = bR\Delta\theta$$

Therefore

$$P_{max} = \frac{T}{Rb}$$

While this simple equation may be solved quickly with the slide rule, it often is necessary or desirable to go through it several times to obtain the most suitable values. For this reason, the chart in Fig. 2 was constructed, which, with its two auxiliary scales enable the solution of the equation determining the area of the band:

$$A = .0174530^{\circ}Rb$$

This, in turn, is used in computing the average pressure:

$$p = \frac{T-t}{u\,A}$$

This equation follows from the definition of u and, as stated before, the value found is used by makers of lining materials as a guide for recommendations as well as for comparative purposes.

Thus, we find that the band presents a problem of its own which can be solved partially by computation and partially by experience. Some of the other factors which affect the design of a band are based upon experience alone. For example, it has been shown by tests that a band which is too wide produces failures. The solution is the use of two narrow bands with equalizing connections. It is important on inside bands particularly to have them as near perfect circles as possible. Such problems as chatter and grab-

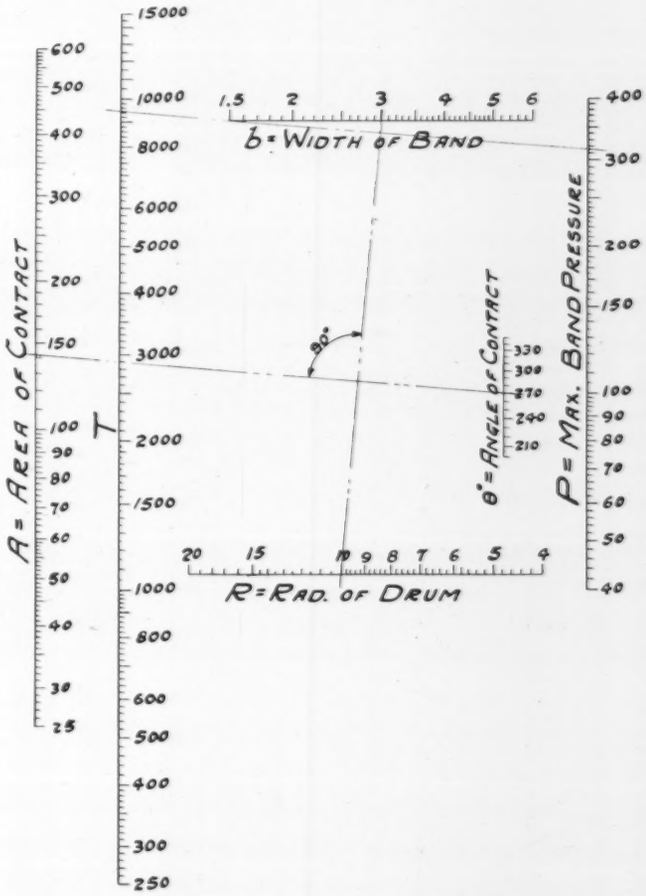


Fig. 3—Determination of maximum pressure and area of band is facilitated by use of this chart

bing or heat dissipation and timing of applications to average operation of the machine, are also considerations to be based upon tests. The first pair are particularly disconcerting since the fault may lie in the design of other parts of the machine. Finally, let us not forget that while the use of mathematical formulas can be only approximate, the results still are valuable for their comparative information to work hand in hand with experience on similar designs on which some of the foregoing problems have been solved satisfactorily.

Specifying Close Limits Is Futile Without Suitable Finish

By R. E. W. Harrison

PARTICULARLY in these days of cost reduction, slow and expensive operations are under critical review. Pertinent data is given on specification of finishes in the accompanying abstract of a paper presented at the recent annual meeting of the American society of Mechanical Engineers. Mr. Harrison speaks from a broad background of training and knowledge. He now is engineering director, Cincinnati Grinders, Inc.

IT GENERALLY is known and accepted that the method of removing metal which involves the use of a hardened tool, the nose of which penetrates the surface to be machined to the required depth, leaves a relatively torn and disrupted surface which has a high coefficient of friction and a relatively high initial wear. It is not proposed in this discussion however, to treat the relative merits of machined and ground work, but to deal with the finer irregularities produced by the accepted finishing operation of today, i.e., grinding.

The modern grinding wheel, which is built up from an accurately sized, accurately spaced, and carefully bonded abrasive, is in itself a tool of precision, produced by its makers to within limits of accuracy controlled within thousandths of an inch. Examined by the naked eye after being mounted and trued in a modern precision machine, the working surface of this wheel presents a smooth and precise appearance. However, when this wheel and the work on which it is operated are viewed through the microscope, it will be realized that modern precision grinding is nothing more or less than a closely controlled milling operation in which each of the particles of abrasive presented to the work plows its quota of metal and leaves its resulting furrows.

While one may overlap and overlap the path taken by succeeding particles of abrasive, the resultant surface under a powerful microscope has much in common with a plowed field, as may be seen from Fig. 1. Sharp ridges of steel or iron exist on the surface of the work, and these must be removed before one can arrive at a plane surface which will have a maximum resistance to wear.

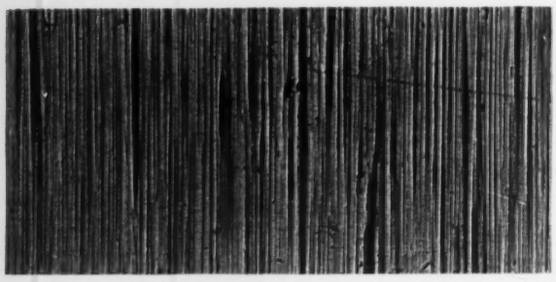


Fig. 1—Photomicrograph of surface ground to generally accepted finish with 80-grit wheel, x 75

A world-famous maker of diesel engines, of both the marine and the land operating type, found that reduction in initial wear due to bettered methods of finishing enabled him to control his sizes so accurately that he reduced the running-in time of his engines to one-third of that previously found necessary, and at the same time increased the power-producing efficiency of his product by eight per cent.

Magnification Discloses Finish

Let us consider surfaces produced on cylindrical work, and discard for the moment the questions of accuracy as regards roundness and parallelism. A representative plan view of an automobile wristpin ground to a finish which generally is considered good and acceptable by manufacturers who judge their product only by the naked eye is shown in Fig. 3—(left). The finish-grinding operation was performed with an 80-grit grinding wheel. Fig. 3—(right) shows the same piece reground with a 500-grit grinding wheel, and Fig. 4—(left) shows the same piece after being put through a lapping operation in which the pin is held on a spider between abrasive disks that were mounted on vertical spindles.

Fig. 4—(right) shows the same piece after being again passed through the grinding ma-

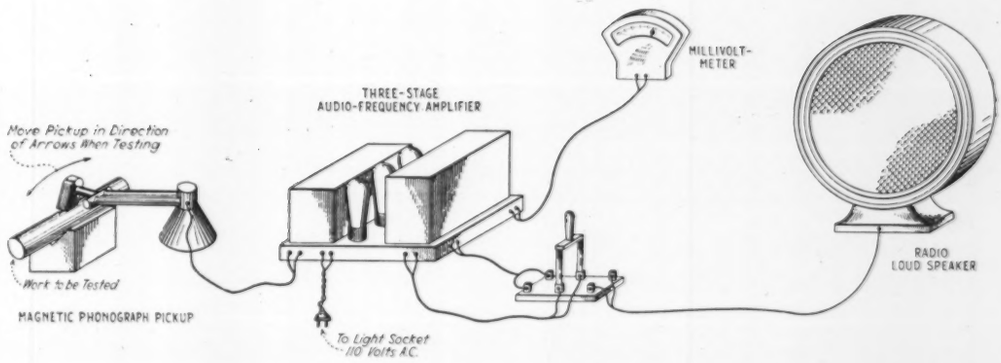

MILLIVOLT-METER
THREE-STAGE AUDIO-FREQUENCY AMPLIFIER
Move Pickup in Direction of Arrows When Testing
RADIO LOUD SPEAKER
Work to be Tested
MAGNETIC PHONOGRAPH PICKUP
To Light Socket 110 Volts A.C.

Fig. 2—Diagrammatic view of finish calibrator embodying an electromagnetic sound detector to record surface irregularities

chine following on the lapping operation. It will be noted that the grinding operation with the 500-grit grinding wheel has not been continued long enough to remove all the marks left by the laps. The hitherto frequent renewal of automobile wristpins resulted in intensive study being given to this member, with the result that a large percentage of pins built into new automobiles and those used as replacements are either ultra-finish-ground with a 500-grit grinding wheel or are lapped.

Experience indicates that there is no short-

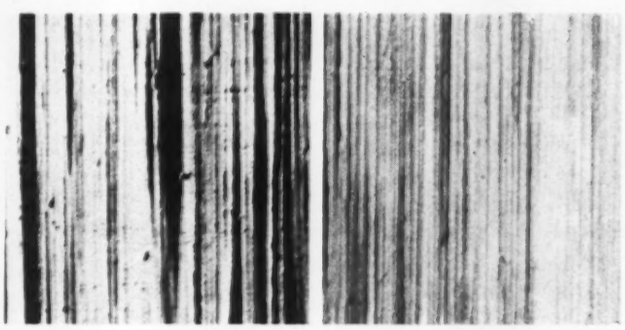


Fig. 3—(Left)—Working surface ground with an 80-grit wheel. (Right)—Surface produced with a 500-grit wheel. X 100

cut to a really high finish. Such finishes necessarily must be built up by successive stages. Grinding wheels designed for producing the highest class of finish are incapable of an attractively high rate of metal removal. Hence a practice has grown up whereby the bulk of the grinding allowance is removed with a wheel of from 60 to 80 grit. An intermediate finishing operation utilizing a wheel of 120 to 250 grit is interposed to top off the ridges caused by the grain depth of cut of the roughing wheel, and the final finish is imparted to the work with a wheel which may vary from 250 to 500 grit, the final result depending upon the standard of finish necessary for the satisfactory accomplishment of the work. Attempts have been made to effect a shortcut, but these have all resulted in the building up of a false finish. In other words, the ridges are turned over into the hollows, and in actual service the results obtained from this finish are not satisfactory.

Through the period of years in which mechanical processes have been developing, no satisfactory method of gaging finishes, other than with the eye, has been developed. In an attempt to obtain a solution to this problem in a practical workshop way, the author has adopted the following procedure. A small rack carrying 1-inch diameter cylindrical plugs ground to the various progressive standards of finish has been placed in each of the following departments for reference; engineering, grinding, inspection, standards, and laboratory.

Device Records Surface Irregularities

The question at once arises as to how these standards are established, and this has been accomplished in the following way: A finished-measuring device has been put into use, embodying an electromagnetic type sound detector or pickup as used in the better makes of electrically operated gramophones. The device is shown in Fig. 2. This instrument is connected up with a radio amplifying unit and records minute vibrations caused by irregularities on the surface of the work to be inspected, reproducing them through a loud speaker. The contact with the work is made with a chisel-edged sapphire, and a millivoltmeter records the amplitude of a current which is directly proportional to the vibration, and which passes across the grid of a supplementary radio tube.

Work which is relatively roughly ground pro-

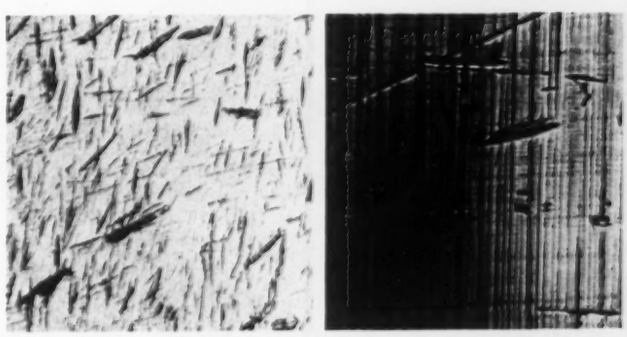


Fig. 4.—(Left)—Typical example of lapped surface. (Right)—Surface after lapping and subsequent grinding with 500-grit wheel. X 100

duces a deep, harsh vibration in the loud speaker and a relatively large movement of the needle on the millivoltmeter scale. A finely ground piece of work produces a keen high note characteristic of minute vibration, and results in a relatively small swing of the millivoltmeter needle.

From the foregoing description it will be seen that there is available both sound and visual measurement on a definite scale to supplement the microscope and the naked eye. The instrument is extremely sensitive and particularly well suited to picking out that class of unsatisfactory work which, in the every-day phraseol-

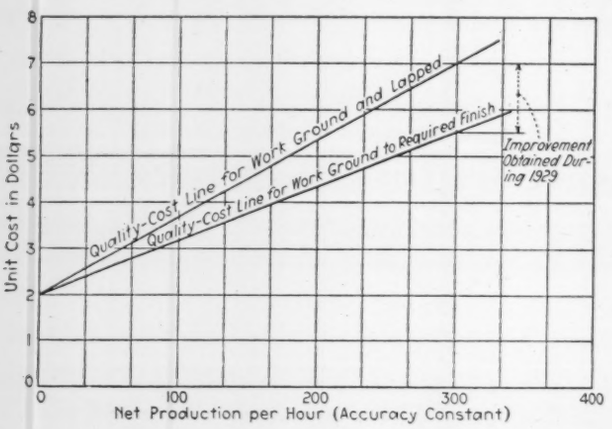


Fig. 5—Quality cost diagram showing reduced cost of finishes due to improved methods

ogy of the mechanic, is "highly polished and deeply scratched."

It being accepted that there is no available shortcut to high finish, it follows logically that the higher the finish the higher the cost on any given piece of work. However, much has been done in an endeavor to improve the standard, and the diagram in Fig. 7 serves in a general way to indicate what has been accomplished during the last year or eighteen months.

Combating High Initial Wear

The relationship between quality and finish, as discussed in the foregoing, and accuracy, considered as a commercially attractive factor from the point of view of the works management, may at first appear to be somewhat obscure. However, experience indicates that the two subjects are closely related by that relatively indeterminate factor known as initial wear. Until one is in a position to produce work with practically no initial wear, it justly might be said that he is being deceived in the belief that work is being held within the specified limits of accuracy stated on the drawing. The effects of this knowledge of the existence of high initial wear can be seen on every hand.

(a) Designers frequently tighten up their limits in the hope that when the initial wear has taken place they still will have mechanisms which operate without shake or without losing gas, air, or oil pressure.

(b) Designers frequently call for extremely expensive handlapping operations, knowing that this, being a slow process, offers maximum insurance against the assembly of parts which otherwise would retain possibilities of high initial wear.

(c) Makers of twist drills and plug gages insure that their products have a maximum useful life before the fuzz is worn off them and they are reduced to the low limit.

(d) Engine builders make their pistons larger in diameter in relation to the bore to insure that when the engine comes off the dynamometer test it will not have too much piston slap.

(e) The preloading of antifriction bearings is another effort in this direction.

(f) Builders of high-class machinery erect, dismantle, inspect, re-erect, run, dismantle, inspect, re-erect, and run again to check up the results of initial wear known as the bedding-in process on their shafts and bearings.

Limit System Is Important Factor

One of the factors most closely affecting the manufacturing success of any modern organization is the intelligent use of the limit system, for in the specifying of close or wide limits the engineering department either can make or break the successful operation of any plant.

It is obviously most sound for the designer to specify the widest possible limits of accuracy consistent with the satisfactory functioning of the piece or mechanism under consideration. There is evidence, however, that the question of initial wear does not always receive the consideration which its importance entitles it to, and it is becoming increasingly necessary for designers also to specify the class of finish on the bearings and sliding surfaces which operate under load. The absence of a definite standard of finish has been a great obstacle, but it is hoped and anticipated that research work shortly will clear away this barrier.

IN REORGANIZING recently the American Society of Mechanical Engineers sectional committee on plain limit gages for engineering work decided to change its name to "Allowances and Tolerances for Cylindrical Parts and Limit Gages." Edward J. Kearney, secretary-treasurer, Kearney-Trecker Corp., West Allis, Wis., presided as permanent chairman and was empowered to appoint such subcommittees as he deemed necessary to perform the task assigned to the sectional committee. A review and revision of the present American standard for tolerances, allowances and gages for metal fits will be undertaken first.

High Strength Cast Iron Keeps Pace with Times

WITH the intensive demand for increased production speeds on all classes of machines has come the need for improved materials of construction, this being true particularly in the case of machine tools on which the new carbide cutting tools are employed. Producers of iron castings and alloy irons are meeting this need. In the accompanying article data is given on one of the newer air furnace irons which offer wide and interesting possibilities.

CAST iron has been used for centuries and is a comparatively inexpensive material. Although great progress has been made in the steel industry and alloys of various kinds have improved the physical properties, shock resistance, corrosion resistance, etc., of steel and other materials, cast iron remains the most suitable material that can be employed for many applications.

Besides possessing great compressive strength cast iron offers high resistance to corrosion. While it is considered a relatively brittle material, this fact is at times an advantage as its low elasticity is a guarantee that it will not change its shape readily and therefore has good resistance to deformation. Machine parts particularly are designed to function below their elastic limit. Therefore a material other than cast iron having a high tensile strength with a relatively low yield point does not have the advantages over the iron which might at first glance be considered apparent.

The matrix of cast iron is similar to that of steel and in itself has correspondingly high tensile strength. Free carbon or graphitic carbon in cast irons is the weakening factor in the ultimate strength of an iron casting. This graphitic carbon, however, influences the functioning of cast iron parts as it prevents "galling" and "sticking" on reciprocating parts due to its lubricating qualities and its ability to absorb lubricants used.

As the graphitic particles are natural cleavage planes cutting through the grains of the iron matrix, it is necessary to reduce these particles in size, and gain a uniform distribution of them, in order to increase the strength and physical properties of the iron.

One of the pioneer companies which has by extensive research and development work helped to make the often despised cast iron keep pace with modern progress in the metallurgy of ferrous metals is the Gunite Corp., Rockford, Ill. This company manufactures an air furnace pearlitic iron that is being used for various parts such as cams, gears, slides, tables, ways and hydraulic parts.

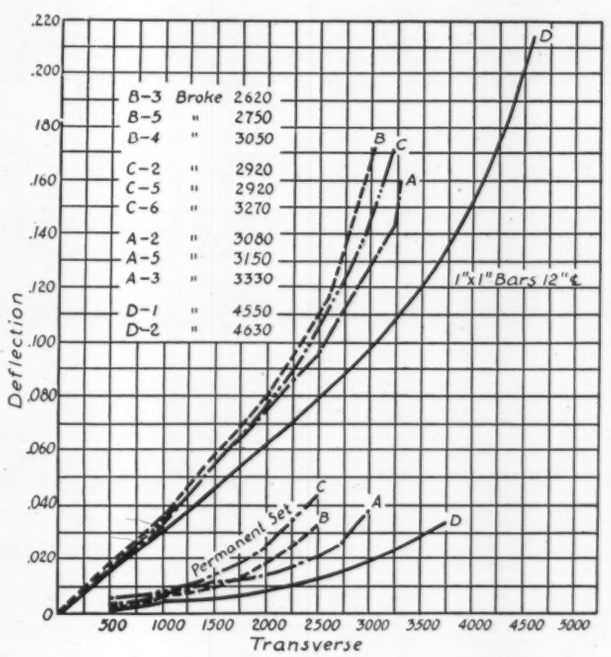


Fig. 1—Chart showing deflection of air furnace pearlitic iron with comparative irons made by cupola process. D represents air furnace iron

Close Grained Structure Provides Strength

The outstanding characteristic of this material is its close grained uniformity regardless of section and its high tensile and transverse strength. It will average 6000 pounds transverse strength and 50,000 pounds tensile. An idea of its rigidity and deflection plus its ability to resist permanent set can be obtained from the chart in Fig. 1.

As the machine designer allows a sufficient

safety factor to guard against breakage of various machine castings, it is obvious that the deflection of the specific parts is the controlling factor in determining the cross sections that should be employed in each particular design.

It readily can be seen, therefore, that a casting having physical properties and greatly reduced deflection under equivalent loads offers the designer a material having the following advantages:

1. Lighter sections can be employed having the same strength as the heavier sections of conventional iron.
2. The same sections in this material as of the conventional machinery iron increases the strength and rigidity of the particular castings used.

As all machine castings necessarily must be machined, it is interesting to note that the high physical properties are obtained without impair-

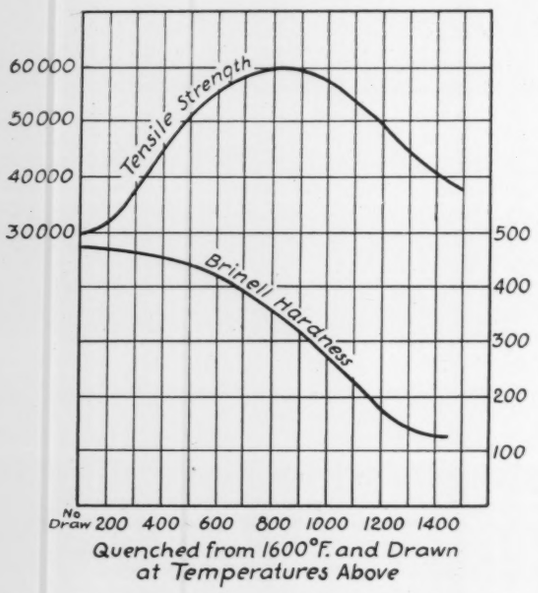


Fig. 2—Hardness and tensile strength are indicated in above chart

ment of machining qualities. Brinell hardness from 190 to 210, a uniform pearlitic matrix and freedom from hard cementite areas allows the material to be machined at speeds that compare favorably with the speeds used for average iron.

An example of this iron's ability to stand up under extreme conditions on reciprocating parts is proven by the following test made by a nationally known machinery builder:

Test blocks showed brinell of 196.

Machine runs at 150 strokes per minute.

Blocks were thoroughly lubricated for a period of 13½ hours, run under pressure of 120 pounds per square inch for 6 hours and 240 pounds for 7½ hours.

After running for this period the blocks were taken out, all oil removed, and replaced in the testing machine. They then were run under increasing pressures until 360 pounds per square inch was attained. Under this condition the blocks ran 91 hours without lubrication before scoring took place and machine stopped.

This made a total of 104½ hours these blocks ran under test. During these tests, temperatures ranging from 105 degrees Fahr. to 154 degrees Fahr. were reached. Room temperature of 72 degrees Fahr. to 75 degrees Fahr.

Metal of this type must be made under metallurgical control, but this control plus air furnace practice makes it comparatively easy to produce castings having a uniformity of structure that it is almost impossible to obtain with the best of care in ordinary practice.

While weight is a factor in design of certain machines, there are many parts where a material having a higher modulus and greatly increased rigidity can be employed to advantage, in lighter sections, particularly on reciprocating parts.

Oil or Water Hardening Is Possible

A great number of cams of this material and also worms are used in the heat treated condition. Due to the high combined carbon content and the low sulphur content this material, like steel, can be hardened in either oil or water by quenching from 1600 degrees Fahr. The chart in Fig. 2 gives an idea of the hardness and tensile strength obtainable after tempering.

The hardened material has the peculiar property of absorbing in its structure about ½ to 1 per cent of its volume in oil. Graphitic particles which are distributed throughout the entire structure are not altered in hardening and seem to serve as wicks. For this reason hardened Gunite iron has unusual properties as a bearing material.

The development of the new carbide cutting tools and the increased power necessarily put back of these tools to capitalize on their superior cutting qualities, is a challenge to the machine designer to develop machines to utilize this latent power. This condition can be met by an increase in the cross section of the casting employed or by the use of a higher strength material. A certain amount of weight is desirable in machine castings but sections increased over definitely known areas may be a detriment rather than an advantage. It is well known that the average cupola cast iron cast in heavy sections is comparatively weak and open grained in the center of such sections. Thus it often happens that sections are increased in area and weight without gaining any increase in rigidity.

The air furnace iron under discussion can be poured in sections 6 x 6 inches square and will have a pearlitic matrix throughout averaging over .60 in combined carbon. Pattern shrinkage is equivalent to ⅛-inch per foot and the iron has sufficient fluidity to be poured into the lightest sections.

Meeting Unusual Requirements in Mechanical Units

By L. D. Peik

Chief Engineer, American Foundry Equipment Co., Mishawaka, Ind.

EXPERIENCE has indicated to the writer that the "try-and-err" method of design still is sound where certain conditions are unknown, granting that good engineering sense has been applied to eliminate inherent and fundamental errors.

Machines subjected to unusual service involve consideration as to maintenance, operating economy and the possibility of future improvements. Sand cutting and preparation equipment for foundries comes in this category and has been selected as the subject of the following discussion.

Contrasting this type of machinery with other equipment in foundries, it might be said that cranes, conveyors, elevators, molding and core machines, screening and mulling machines, jolters, tumbling barrels and charging equipment, are confined to fixed tracks or foundations and perform routinal operations. On the other hand, sand cutting and sand preparation equipment for molding is intended to serve a variety of floors, or be transported from department to department. It therefore must be flexible. The machines under consideration are adapted to operate on wood, concrete and dirt floors. There also is the possibility of electric current not being available for sand cutting use. In such cases a gas engine has to be substituted for the electric motor, and facilities are provided for making the change.

Obstacles encountered with this type of equipment are varied, due to the nature of the plants in which it is used. In nearly every foundry, sand cutting equipment is operated only nightly, which is at a time when the greatest care is not observed. Frequently, after the machine has been in operation all night and the work is completed, the machine is stored in an adjoining shed in a temperature possibly below zero. This immediately involves a problem of lubrication. Only a low temperature lubricant with a high flash point must be selected. Seldom does the maintenance department concern itself with the sand cutter after the night's work is finished, unless a certain breakdown is reported. This all adds to the abuse of the machine.

The various operating conditions such as piling, after the sand has been thoroughly aerated, and depositing the finished sand in windrows for molders, always is a new experience, especially when it is necessary to drive the machine over

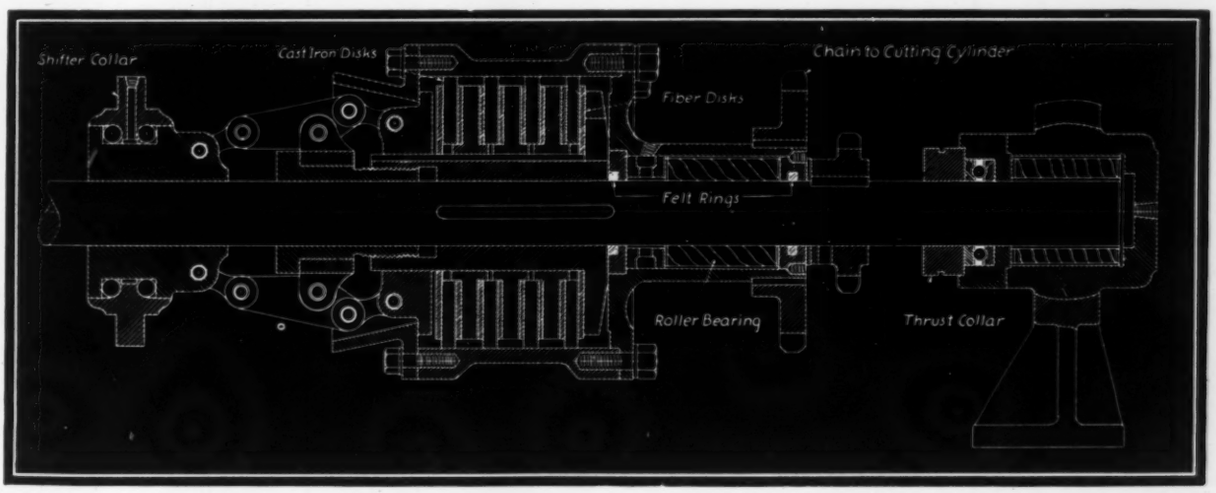


Fig. 1—Main shaft of machine from which various drives are taken. Note heavy duty friction clutch and toggle arrangement for exerting pressure on disks

shakeout iron and sand piles. Frequently castings are left in the shakeout sand and thus come into clash with the cutting cylinder blades, producing a violent shock which must be absorbed by some parts of the machine. This constitutes one of the chief reasons for the frame being built up entirely from steel castings and structural members, electric welded.

To provide a machine which can be maintained easily by the type of unskilled labor usually employed in foundries, all parts have been designed to be accessible readily. Lightness of mechanisms and of the complete machine also has received consideration, this being essential from the aspect of portability.

A single power unit drives the cutting cylinder, and also propels the machine in the forward and reverse directions. Front wheels operate in roller bearings, dust sealed, and are mounted on upright housed spindles which have a controlled arrangement for steering by vertical, equalizing movement to compensate for uneven floors. This arrangement operates by means of a bell crank lever in contact with the top of each steering column, and a transverse bar con-

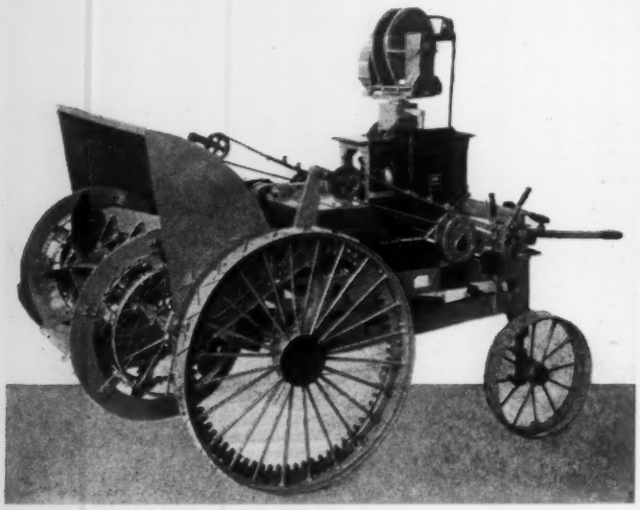


Fig. 2—Light duty machine on which internal drive for rear wheels is employed

necting the other ends of the levers.

The operator steers the machine by a forward hand lever, with notched quadrant, the lever acting through connecting rods and cranks which turn the spindles of both front wheels in unison. Short turns can be made and the machine manipulated to a nicety in close quarters, all controls being conveniently located for quick action, as may be seen from the illustration of the machine in Fig. 2. The arrangement of controls is simplified because there are less levers to operate and they are more easily reached. Handles are equipped with heavy duty rubber grips.

Rear tractor wheels are made of steel, with malleable treads. Roller bearings usually are used in the hub of each wheel. In Fig. 3 is shown an alternative in the form of a plain bearing wheel, with adjustment for tightening the driving chain used on this type of wheel. It will be noted that the wheels are designed to take excessive shock by means of springs which are mounted between the four driving arms and the wheel rim. The springs compensate also for uneveness in floors and peak loads in cutting sand.

The transmission includes two speeds forward

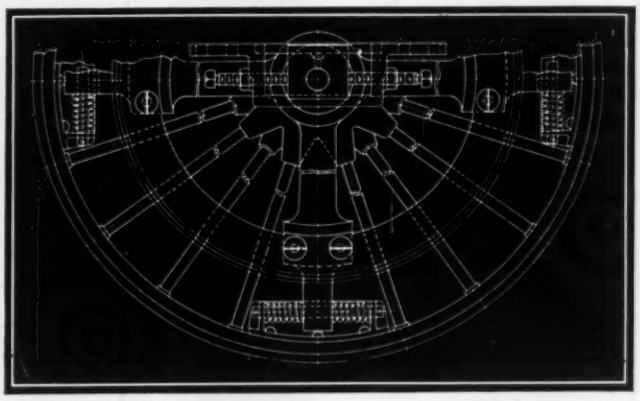


Fig. 3—Wheel designed to withstand excessive shock by means of spring mounting

and two reverse, operated by lever controlled friction clutches, and driving through an automatic differential. Clutches are of the multiple steel plate type, employing 25 plates each running in oil.

The motor, connected through a flexible coupling to a worm gear reducer, is of cross-the-line, high resistance, normal torque type, and operation is by a master push button switch. Current is supplied to electrically driven machines through a heavily insulated cable, which plugs into receptacles and is taken out from an automatic tension reel on the machine. Power is distributed through a heavy duty friction clutch, shown at the left of Fig. 1, and a roller chain drive for rotating the sand cutting cylinder; by a roller chain to a worm gear mechanism for raising and lowering the cylinder; and by other roller chain drives to each rear wheel. For light duty work, however, a wheel is used in which a tooth segment is fastened to the rim, as shown in Fig. 2. The pinion for driving these wheels is of the pin wheel type, instead of being made with cast or cut teeth.

It will be appreciated that one of the chief considerations in designing a machine of this type is the provision of adequate protection for parts subject to wear due to the presence of dirt and sand. All such parts on the machine under discussion have been fully enclosed, and effective measures have been taken to seal shafts for exclusion of abrasive material as well as for retention of lubricant.

Assets to a Bookcase

Review of Books Pertaining to Design

Theory and Problems

Strength of Materials, by S. Timoshenko; in two volumes, cloth 735 pages, 6 x 9 inches; published by D. Van Nostrand Co. Inc., New York, and supplied by Machine Design for $3.50, volume 1, and $4.50, volume 2, plus 15 cents per volume postage.

With the changing attitude of designers toward analytical methods of solving engineering problems and particularly those pertaining to strength of materials, a book on this subject fills a timely and important position. It is the authors aim to focus the reader's attention on practical applications of the subject. To handle conclusively the task, he has divided the work into two volumes. Beginning with elementary theory, such problems are discussed as tension and compression within elastic limit, combined stresses, torsion, statically indeterminate problems in bending, stresses due to direct and bending loads, and combined bending and twist.

Advanced theory and problems comprise the text of the second volume. New developments of practical importance on the subjects of strength of materials and theory of elasticity are given. Theory of curved bars is developed in detail and the application of this theory to machine design is illustrated by an analysis of the stresses, for instance, in hooks, fly wheels, links of chains, piston rings and curved pipes.

Further on Prof. Timoshenko discusses problems of stress distribution in parts having the form of a generated body and symmetrically loaded. In the last chapter mechanical properties of materials are discussed. Attention is directed to general principles rather than to a description of established, standardized methods of testing materials and manipulating apparatus. Such subjects as the fatigue and strength of metals at high temperatures are of decided practical interest in modern machine design.

□ □ □

On Design Principles

Applied Mechanics, by Alfred P. Poorman; cloth, 297 pages, 6 x 9 inches; published by McGraw-Hill Book Co. Inc., New York, and supplied by Machine Design for $2.75 plus 15 cents postage.

Minor changes have been made in the arrangement of the text for the third edition of this book which gives a comprehensive explanation of the subject. One of the features is the graphic method of solution, a process which is being recognized increasingly by the design profession.

Following paragraphs dealing with the separate theories or principles, the author gives a worked out example, another feature which adds to reader value and interest. First chapters outline fundamental definitions and graphic solutions of force diagrams. Solutions for the more complicated systems of forces and moments acting on a body follow. Chapters on friction, centroids and moments of inertia also are covered in the first part of the book.

Principles of kinematics are treated in the second part and the mechanics pertaining to many practical problems are presented. Balancing of rotating bodies, kinematic reactions on connecting rods, balancing of reciprocating parts and a chapter on impulse, momentum and impact comprise an important part in the subject matter.

In revision, Prof. Poorman has added some additional examples to clarify principles. A large number of problems used in the second edition have been replaced by new ones. As in former editions, answers to all problems have been given.

□ □ □

A Book About Welding

Weld Design and Production, by Robert E. Kinkead; cloth, 97 pages, 4 x 6½ inches; published by the Ronald Press Co., New York, and supplied by Machine Design for $4 plus 15 cents postage.

Problems arising in welding as a repetitive manufacturing process are discussed exhaustively by the author who presents information on welding as applied to design and production. The principal topics considered are how to design safe and sure welds; how to control the manufacturing process to insure the production of the welds designed; and how to predict and control the cost. Information also is given on design which shows exactly what happens inside the weld under service conditions.

Effect of different metals in the weld and the pieces welded, changes which take place in metals joined by welding, effect of fatigue of metals and corrosion on welds and method of calculating the residual strain in the weld, are topics considered by the author. Equalizing distortion in a weld and estimating costs also are discussed.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Larger Suction than Discharge

To the Editor:

THE explanation given by Mr. Parrish in your December issue as to why the suction connection of centrifugal pumps sometimes is made larger in diameter than the discharge, namely: in order to reduce the total suction head, is correct so far as it goes, but does not mention another consideration which probably has been much more potent in influencing many pump builders to adopt this feature.

In calculating the efficiency of centrifugal pumps where the discharge nozzle is smaller than the suction nozzle, it is customary to credit the pump with the gain in velocity head represented by the higher velocity in the discharge nozzle. While this is strictly correct from the point of view of mechanics, it is not sufficient if the purchaser of the pump has occasion to compare the efficiency of such a pump with that of a pump having both nozzles of the same size, or having a different ratio of nozzle sizes.

The efficiency of a machine which has for its purpose the transfer or transformation of energy ordinarily is defined as the ratio of the energy output to the energy input. The energy input of a centrifugal pump is the energy applied to turning the shaft, while the energy output is calculated as the volume of fluid handled multiplied by the increase in pressure generated, or as the weight of fluid multiplied by the head pumped against. The total mechanical energy of a fluid, however, includes pressure head, elevation head and velocity head, all of which must be considered.

Gain in pressure may be measured readily, and any difference between the elevations of the nozzles must be taken into account as elevation head.

The remaining item, velocity head, sometimes is overlooked and sometimes misunderstood by the pump user. Velocity head is the vertical distance in which a freely falling body would gain the velocity being considered.

The velocity of the fluid as it enters the suction nozzle or leaves the discharge nozzle of a centrifugal pump is calculated readily by dividing the flow in cubic feet per second by the cross sectional flow area in square feet. If the areas of the suction and discharge nozzles are equal, there is no correction for velocity head, but if one is larger than the other, the difference in velocity head is added to, or subtracted from, the pressure head developed by the pump.

The rule given in the *Standards of the Hydraulic Society* reads:

"If the discharge pipe is of smaller diameter than the suction pipe, which often is the case, then it will be necessary to add to the total head, as shown by the gages, the difference in velocity head between that of the discharge and that of the suction pipe at the points where the gages are connected. If the discharge pipe is larger than the suction pipe, the difference in velocity head must be subtracted from the total head."

From the point of view of energy transferred to the water in the pump, the theory of this rule is entirely correct, but it can lead to considerable error in evaluating pump utility.

Piping Arrangements Must Be Considered

The complete installation, including the piping arrangement which will be used with the pump, should be considered when comparing efficiencies, and it should be borne in mind that a pump having the proper size of nozzle may give a great useful effect, even though its guaranteed efficiency is lower. This applies particularly to low head pumps, where the velocity head constitutes an appreciable part of the total head.

As the velocity in the pump volute is always much higher than in the discharge nozzle, one of the problems of the pump designer is to convert this high velocity into pressure as efficiently as possible, but it is easier for him to leave the velocity high, clear up to discharge nozzle.

The better showing made by the pump having a small discharge nozzle will be more than offset by loss in the piping unless an efficient straight increaser is put in between the pump discharge flange and the pipe line.

In any event, a pump which has a discharge

nozzle smaller than the suction nozzle should not be given full credit for velocity head in comparing it with a pump having both nozzles of the same size, since it is impossible to convert 100 per cent of the velocity into pressure, even with the best piping layout.

—GEO. H. GIBSON
New York

Indexing by Silent Chains

To the Editor:

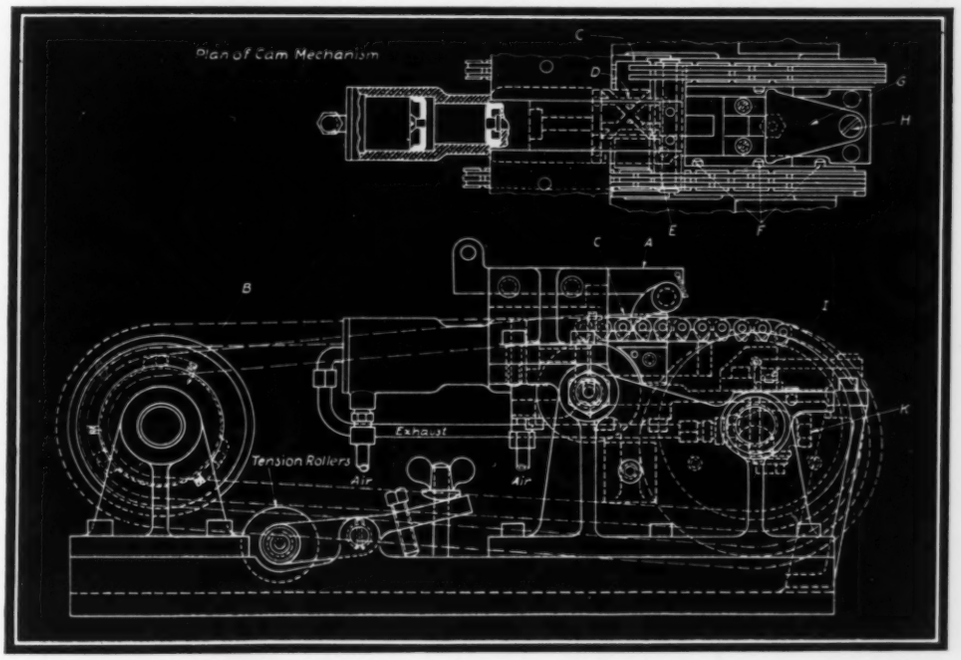
INDEXING specifications requiring a movement by which different spacings could be obtained in one cycle necessitated the development of a mechanism incorporating several unique design principles. The unit, shown in the accompanying illustration, fulfills the requirements in that it provides 18 spaces of one dimension, followed by five spaces of a larger dimension. The cycle, or one revolution of the indexing shaft, is complete when each set of spacings has been performed twice.

A crank and pitman on the principal part of the machine transmit a reciprocating motion to the slide, *A*, carrying pawls which subsequently perform the indexing by engaging in the links of a chain. The slide is set to travel so that two teeth in the sprocket will be used at each stroke. Since the stroke of the slide is uniform, the difference in the spacing is obtained by the use of sprockets of different diameters, which operate independently of one another, and are located on either side of a roller clutch drum, *B*. Motion is transmitted to the clutch drum by means of three cam pockets spaced evenly around the drum. The rollers are held in close contact by thrust blocks as shown. This clutch is, of course, similar to the automobile free wheel roller clutch developed recently.

Each index on the large sprocket revolves the indexing spindle a fewer number of degrees than an index on the smaller sprocket, since the large sprocket gives the required spacing for the 18 spaces which are smaller than the five spaces indexed on the other. In order to control the pawls so that they will index first on one side, then on the other, a shield, *C*, is provided which alternately disengages the pawls on the sprockets, the pawls on one side riding on the shield while those on the opposite side are indexing. The shield is fastened directly to and controlled by a cross cam, *D*, which is actuated by a follower block, *E*, set in the rod of a piston.

A differential piston operated by compressed air is used in the installation to control the motion of the cross cam. Air is maintained under pressure in both ends of the cylinder, and, because of the larger area of the one end, the piston is held normally in the position shown. Its operation is controlled by the sprockets at the rear which carry pins, *F*, set so that as they come to the top of their cycle they will come in contact with the cam, *G*, which pivots at *H*. When this cam is pushed over it compresses the stem, *I*, of the valve, *K*, which releases the air at the large end of the piston through the exhaust. With this pressure released, the air then acts on the small end of the piston to drive it back. As it comes back, the follower in the cam riding through a groove set on an angle on the under side of the cross cam, *D*, brings

(*Concluded on Page* 62)



Application of an unusual cross cam design, D in the plan view, provides for the transference of indexing motion from one of the chains to the other and permits the use of two sets of spacings without adjustment to the unit

MACHINE DESIGN

Editorial

What Part Will Electric Eye Play in Design of Machines?

NOTWITHSTANDING its tender age, electronics already has established itself as a most promising aid to industry. In the span of a few brief years it has advanced from the status of a laboratory curiosity to an important place in the applied sciences.

Today many of the principles of electronics are finding application in the nation's life. For instance, the photoelectric cell rapidly is proving its worth in installations where heretofore intricate electrical or mechanical devices were employed. Moreover, through its sensitiveness to changes in intensities of light, it is capable of many functions which previously had been beyond the abilities of mechanical equipment.

No one who has witnessed many of the existing applications of the photoelectric cell can doubt that it is destined to become one of industry's most faithful servants. To witness its ability of selection, its discrimination in sorting articles, its reliability in controlling operations in remote stations or its simple solution of problems which heretofore taxed man's ingenuity to the utmost is to be convinced that henceforth it must be reckoned with by everyone who is charged with the design, construction or operation of mechanical equipment.

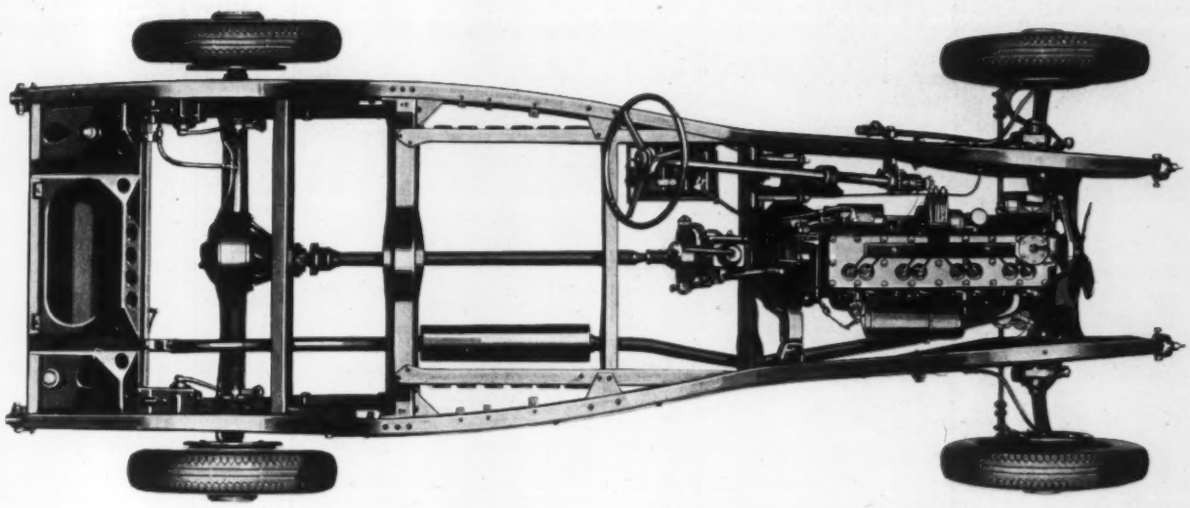
We believe every engineer should be familiar with the applications of photoelectric equipment. The time is not far off when this knowledge will be as important and as essential as the fundamentals of electricity and mechanics.

Consider the User

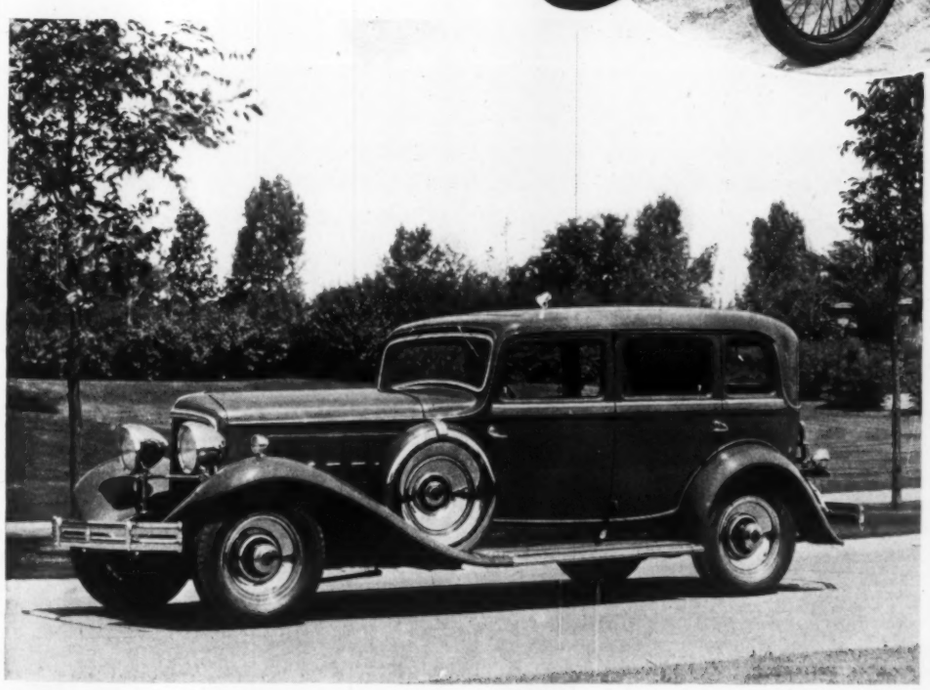
IT'S A far step from the horse-drawn-carriage type of car of 25 years ago to the de luxe models introduced this year. Redesign never has ceased during that period. And it is due to the constant changes and improvements effected that the American automobile industry stands at the top today.

Likes and dislikes of purchasers change rapidly—and cars with them. In few other industries are users considered to the same extent. Trends in size, style, power and capacity are adopted eagerly and quickly by enterprising automobile and body builders. Large and small details alike are brought into line with popular fancies and requirements.

Thus one of the basic industries of the nation maintains and augments its position. Summed up, it designs and redesigns for quick sales. Consequently it has financial resources to continue progressive and effective development.



Evolution in Automobile Design



Characteristic of the progress made in twenty-five years are the illustrations of old and recent cars shown above and at left. The modern chassis is typical of the designer's art in application of new materials and component parts, many of which have been developed due to the rapid advances in design

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

IMPROVED mechanism for oscillating the agitator shaft and for reducing excessive noises caused by the backlash of the gears has been incorporated by George M. Gibson, Pella, Iowa, in a washing machine. Patent No. 1,784,282 recently was granted for the invention and Woodrow Washing Machine Co., Pella, is the assignee.

In designing this gearing mechanism, Mr. Gibson had compactness in mind as well as simplicity and ease of manufacture and assembly. In Fig. 1 is a sectional view of the mechanism showing the manner in which it is applied to a washing machine. Arrangement of gears and the connecting link which operates the agitator are shown in Fig. 2*B*. *C* in Fig. 2 is a detail view taken on line 3—3 of Fig. 1.

Comprising the mechanism in part is the agitator shaft 16 with a rock arm 28 fixed to it. Bearing 25 is provided with a vertically arranged shaft 30 designed to support a crank gear 31 having an opening 32. Wrist pins 33 and 34 are supported in a common plane with link 35 which is mounted close to the top section of the casing to eliminate the necessity of additional means for retaining the pins.

Slidably and rotatively mounted on shaft 36 is gear 45 in mesh with gear 31. The former is provided with notches 46 for receiving lugs 42 of gear 37. Gear 45 has a central portion provided with a friction surface to engage the friction surface of gear 37 at the time the lugs 42 are in notches 46.

The parts are so arranged that as rod 51 is elevated, the gear 45 also will be elevated, drawing lugs 42 out of notches 46. This action provides means whereby gears 45 and 37 may be thrown out of contact with each other and takes the washing machine in and out of operation. Gears 31 and 45 are of such width that when gear 45 is at its upper limit of movement, the teeth of the gears still will be in mesh.

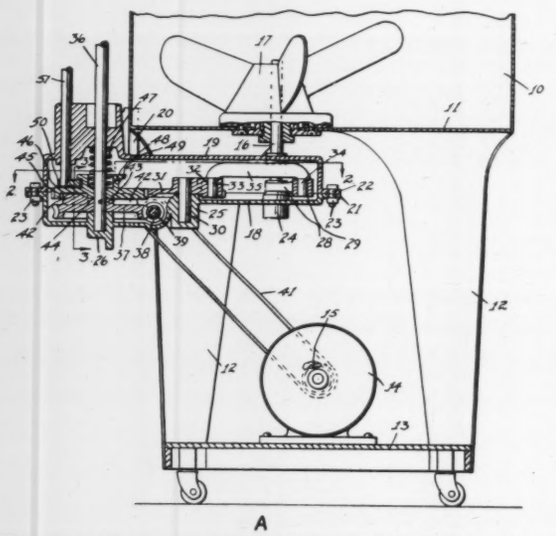


Fig. 1—Constructional details of the gearing mechanism as incorporated in a washing machine

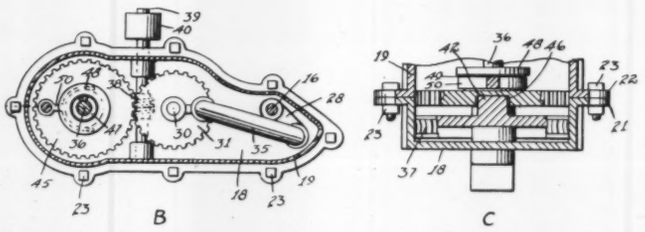


Fig. 2—B—Agitator of washer is operated through connecting link 35. C—Detail view taken on line 3—3 of Fig. 1

As the gear 31 is rotated and the pin 33 of link 35 passes dead center, reverse movement will be imparted to the link. By providing frictional contact between the surfaces of gears 45 and 37, excessive knocking between the teeth of the gears will be modified and the clicking noise eliminated, prolonging the life of the gears and affording quiet performance.

TO AVOID difficulties which arise frequently in connection with the employment of mechanical grippers or fingers adapted to wrap caramels or other sweetmeats with paper, a machine has been designed by Richard A. Harris, Peterborough, Eng., who recently was awarded United States patent No. 1,784,835. Baker Perkins Ltd., Peterborough, is the assignee. Fig. 3 *A* illustrates the suction device in position. A side diagrammatic elevation of the machine is shown in Fig. 3 *B*.

The machine is so constructed that the wrapping papers are engaged by fingers to which they are caused to adhere by vacuum. A wheel *a* comprises a series of pockets *b* each formed

by a fixed jaw *c* and a jaw *d*, displaceable by levers *e* acted upon by cam *f* to permit jaw *d* to close after a caramel has been fed into one of the pockets. Jaw *d* opens to discharge the wrapped piece. The caramel strip is indicated at *i*, being fed by two pairs of forming and feeding rollers *j*, *k*. Rotary knife *m* severs the strip.

Setting of the cam 5 is adapted to synchronize with the movement of the plunger *m'* and correspondingly the movement of the suction device is timed to fit in with the closing of the jaw *c*, *d* of the pocketed wheel. Wrapping paper *r* is fed down in front of the pocket position so that on the forward stroke of the suction device the flat face of the finger 1*a* lie against or immediately adjacent the paper. Knife *s* severs the paper.

As the fingers are about to engage a sheet of paper the vacuum is applied by the action of the pump 8 and the paper is sucked into contact with the fingers. When the lever 2 swings back the paper is moved with and adhering to the fingers. The severance of the paper is followed by a movement of the plunger *m'* to push the caramel *l* which has been severed by the knife *m* between the open jaws *c*, *d* of the pocket *e*. As the plunger *m'* pushes the caramel *l* into the pocket the suction device 6 recedes, drawing the severed sheet around the caramel. As the plunger *m'* finishes its stroke the caramel meets the stop 10 so that the fingers 1*a* of the suction device 6 become detached from the wrapping paper.

THRUST bearings of the self-lubricated type are the subject of patent No. 1,786,565 recently granted to Albert E. Freeman, East Orange, N. J., and assigned to American Telegraph & Telephone Corp.

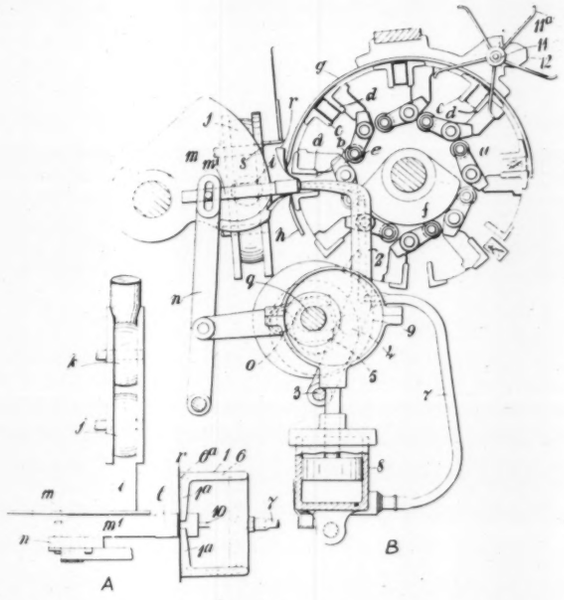


Fig. 3—Suction device of wrapping machine is shown at A. The constructional details and working parts are illustrated in B

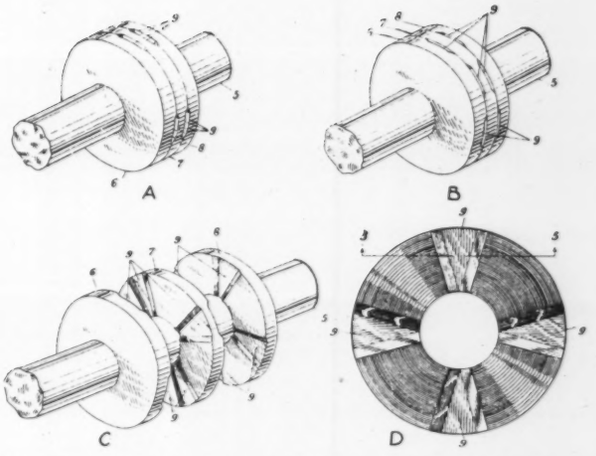


Fig. 4—A—Perspective view of shaft provided with series of disk-like members. B shows grooves in unmated position. Disks are separated on shaft in C, and D is a side elevation of one of the disks

A shaft 5 provided with a series of disk-like members 6, 7 and 8 having grooves in mated position is shown in Fig. 4*A*. *B* shows the grooves in unmated position. Disk-like members are in separated position on the shaft in *C*, and *D* is a side elevation of one of them. The disks are adapted to be rotated in either direction by providing a beveled edge at both sides of the depression.

These beveled edges of the grooves cause a wedging action which forces the lubricant between the flat surfaces of the contiguous members. In this way any tendency of the lubricant being forced out is counteracted by the wedging action which causes the lubricant to enter between the surfaces.

Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

LIGHT-METAL ALLOY—1,788,616. A new product, a magnesium-aluminum-copper-manganese alloy consisting of approximately 93 per cent magnesium, 6 per cent aluminum, 0.7 per cent copper, and 0.25 per cent manganese. Assigned to Dow Chemical Co., Midland, Mich.

CLUTCH—1,789,918. A clutch element comprising a slotted metal body with bars separating the slots, and a friction facing of yarn stitched into the slots, and interlocking portions of yarn in the stitches located in the slots. One-half assigned to Multibestos Co., Walpole, Mass.

ASSEMBLING MACHINE—1,788,601. For assembling externally screw-threaded parts and internally screw-threaded parts together in their proper alignment and means for causing one part to screw-threadedly engage the other part. Assigned to A. Schrader's Sons Inc., Brooklyn, N. Y.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

RANKING high as an authority on the subject of vibration in high speed machinery, Jesse Ormondroyd is one of the well-known figures in engineering today. He is manager of the experimental division of the South Philadelphia works of Westinghouse Electric & Mfg. Co., and as noted in January MACHINE DESIGN, has been appointed with A. L. Kimball to lecture on vibration problems at Harvard Engineering school. Having been graduated from the University of Pennsylvania in 1920 with an A. B. degree and a Phi Beta Kappa key, Mr. Ormondroyd enrolled in the graduate student course of the Westinghouse company at East Pittsburgh, Pa. He then entered the electrical heating engineering department where he remained for two years. In 1924 he went into the railway motor engineering department, transferring to the South Philadelphia works of the company as manager of the experimental division in 1930. Development of friction and dynamic vibration dampers for torsional vibrations in oil electric generating units has been under his supervision at this plant. Business interests have taken him to England, Scotland, Holland, Germany, Switzerland and France and he has lectured at Massachusetts Institute of Technology, Cornell, Michigan, Purdue, and Ohio State universities.

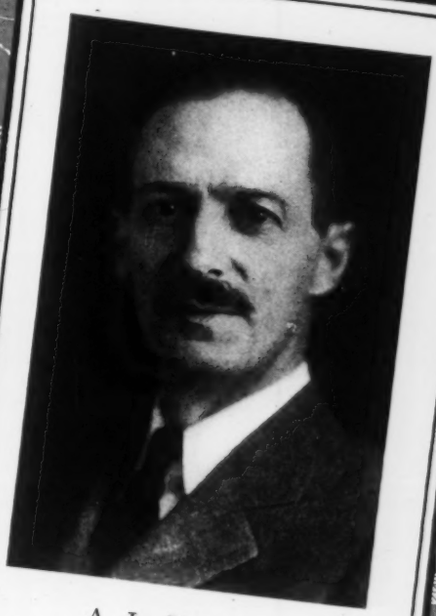
OUTSTANDING discoveries in connection with vibration have been made by Arthur L. Kimball, associate head of the mechanics section of General Electric research laboratory. He has made a special study of fundamentals of vibration damping and his time has been largely occupied with vibration prevention problems. As noted in January MACHINE DESIGN, Mr. Kimball recently was appointed to lecture on vibration at Harvard Engineering school. Baltimore was the place of his birth in 1886. After completing his preliminary education he entered Amherst college, graduating from that institution in 1908. In 1912 he entered Harvard engineering school graduating in 1914 with the degree of master of electrical engineering. In 1917-18 he was instructor in mathematics at Amherst college, after which he entered the employ of the General Electric Co. as engineer in the research laboratory. He worked in close co-operation with the turbine engineering department on turbine wheel vibrations a few years ago, his study resulting in the discovery of the cause and practically the entire elimination of turbine wheel failures. Mr. Kimball went to London in 1919-20 to study Dr. Coker's method of stress analysis by the use of transparent models. During 1928-30 he was secretary of the applied mechanics division of the American Society of Mechanical Engineers.

COMPLETION of his term as president of the International Acetylene association adds another mark to the successful record of C. A. McCune. His successor to that office is W. D. Flannery, K-G Welding and Cutting Co. Inc., New York. Mr. McCune has been interested in welding, welding methods and welding research for 25 years or more and was elected director of research and member of the board of directors of the Welding Engineering and Research Corp., New York, last fall. Previously he had been connected with the American Chain Co., Bridgeport, Conn., and its affiliated interest, Page Steel & Wire Co. As one of the early technical pioneers of welding, he was assistant chief engineer in 1905 and later chief engineer of Commercial Acetylene Co., New York. Mr. McCune has invented numerous devices used in the manufacture of acetylene and its application to welding and lighting. He was one of the founders of the American Welding society and was elected president in 1922. At present he is its treasurer, having held that post continuously since 1923. Among his other activities he is chairman of the welding committee, Chicago world's fair exposition in 1933. He also is a member of the National Research council, Advisory Board of the United States bureau of standards, American Society for Testing Materials and American Society of Mechanical Engineers.

SINCE 1919 Robert S. Archer has been engaged chiefly in the development of heat treated aluminum castings and new wrought alloys of high strength as well as the application

Leaders in Design, Engineering and Research

J. Ormondroyd



A. L. Kimball

C. A. McCune

Robert S. Archer

of alloys and metallurgical processes. His resignation as research metallurgist for Aluminum Co. of America and Aluminum Castings Co., Cleveland, after a 10-year connection, to become director of metallurgy for A. O. Smith Corp., Milwaukee, was announced late last year. Mr. Archer received his early education at Cass Technical high school, Detroit, and his collegiate training at the University of Michigan. After graduating he became research engineer for Detroit Edison Co., Detroit, later becoming identified with Aluminum Castings Co. He is the author of a number of technical papers and has written a book, "Science of Metals," in the preparation of which Dr. Zay Jeffries collaborated. Technical organizations to which he belongs include the American Institute of Mining and Metallurgical Engineers, being a member of the executive committee of the Institute of Metals division; American Society for Steel Treating, being a member of its recommended practice committee and chairman of the nonferrous data sheet committee; American Society for Testing Materials, Institute of Metals of Great Britain, and others.

* * *

Thomas S. Perkins, formerly manager of supply engineering and consulting engineer, recently was made general manager of distribution engineering and will represent S. M. Kintner, assistant vice president, in his work with several departments of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

* * *

William R. Webster, vice president and director of the Bridgeport Brass Co., Bridgeport, Conn., has been named chairman of the American Society of Mechanical Engineers research committee for the coming year. He has been an active member of this committee for the past four years.

* * *

S. T. Nelson has resigned, effective May 1, as works manager of the Sullivan Machinery Co., Elkhart, Ind., after 45 years service. Patents on 28 of his inventions have been assigned to the company. He will devote his time to inventive activities.

* * *

Walter F. Graham has been appointed technical director of the Caskey Brass & Bronze Works Inc., Philadelphia, agent for International Nickel Co. He previously was in charge of the technical division of Ohio Brass Co.

* * *

Harry W. King, formerly head of the engineering department of the Morgan Engineering Co., Alliance, O., has become associated with the Aetna-Standard Engineering Co., Youngstown, O., as assistant to Vice President C. L. Taylor. Mr. King served many years as assistant to Mr. Taylor, formerly vice president of Morgan Engineering Co., and now rejoins him at Aetna-Standard in the same capacity.

* * *

F. E. Dennison, chief engineer of General Refrigerator Corp., Beloit, Wis., recently was elected a member of the board of directors.

* * *

George T. Snyder, chief engineer, National Tube Co., Lorain, O., has been transferred to the engineering department at Pittsburgh.

* * *

R. R. Weddell, formerly chief engineer of the O. K. Tool Co., Shelton, Conn., has been appointed sales manager. E. Reaney will succeed Mr. Weddell as chief engineer.

* * *

F. W. Peek, Jr., has been appointed chief engineer of the Pittsfield, Mass., works of the General Electric Co. He succeeds Guiseppe Faccioli, retired. Mr. Peek, who has been a consulting engineer of the company at Pittsfield, entered the General Electric company "on test" in 1905, following graduation from Leland Stanford university.

* * *

Maurice Olley, for 11 years chief engineer of the chassis division of the Rolls-Royce Co. of America, has joined the engineering staff of Cadillac Motor Car Co. Of English birth and training, Mr. Olley was for many years drafting designer for Sir Henry Royce and at the outbreak of the war he had an important part in the design of the first Rolls-Royce Eagle, a V-12 water-cooled aircraft engine.

PROFESSIONAL VIEWPOINTS

(*Concluded from Page* 55)

the shield under the opposite set of pawls. The pawls then will index the other sprocket which repeats the operation.

The cross cam is so built that the follower block will pass through the longitudinal grooves as the piston returns to the rear of its cylinder. The portion of the longitudinal grooves between the diagonal grooves is sloped toward the rear, depressing the follower block by a spring arrangement as it moves in that direction. When the air pressure on the piston is released and it travels in the opposite direction, the follower block is deflected by the high end of the slope into the diagonal grooves. Its force in a longitudinal direction draws the cross cam to the side as the follower moves down the groove.

—CHARLES T. PLASTOW,
Cleveland

COMPACTNESS!
THE DE LAVAL WORM REDUCTION GEAR is compact, not only as to space occupied, but also in that it combines within itself all qualities desirable in a speed reducer, including:
Immunity to dust and grit
Self-lubrication
Safety to operatives
Simplicity and few parts
Silence
Long life
Smooth flow of power and
High efficiency.
DE LAVAL
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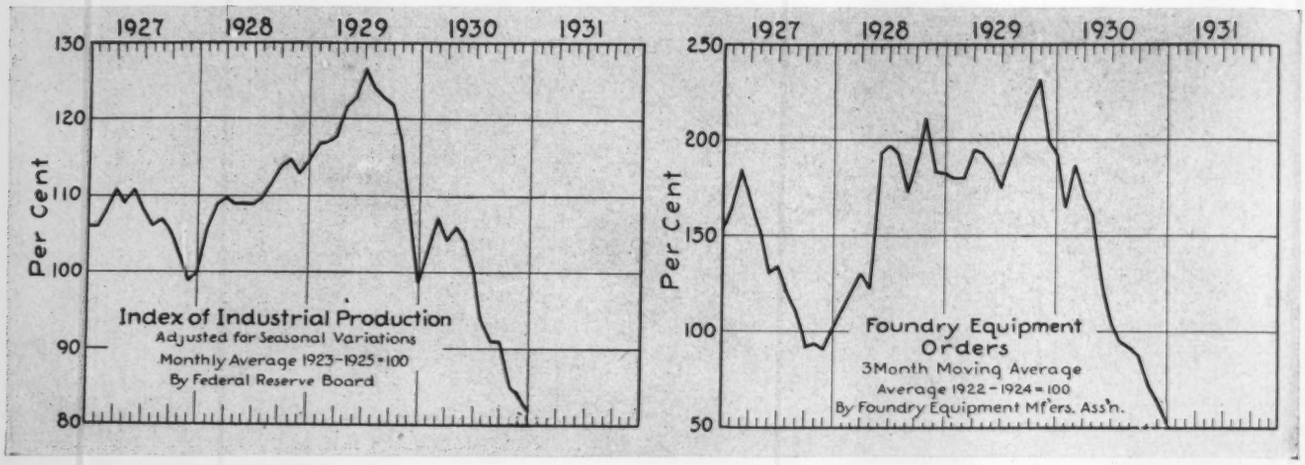
TRENTON, NEW JERSEY

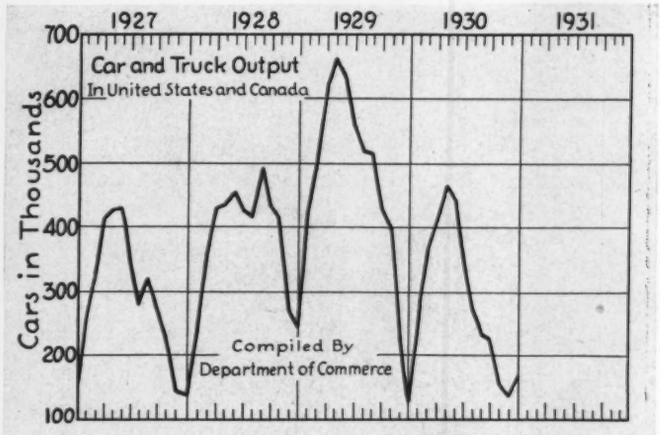


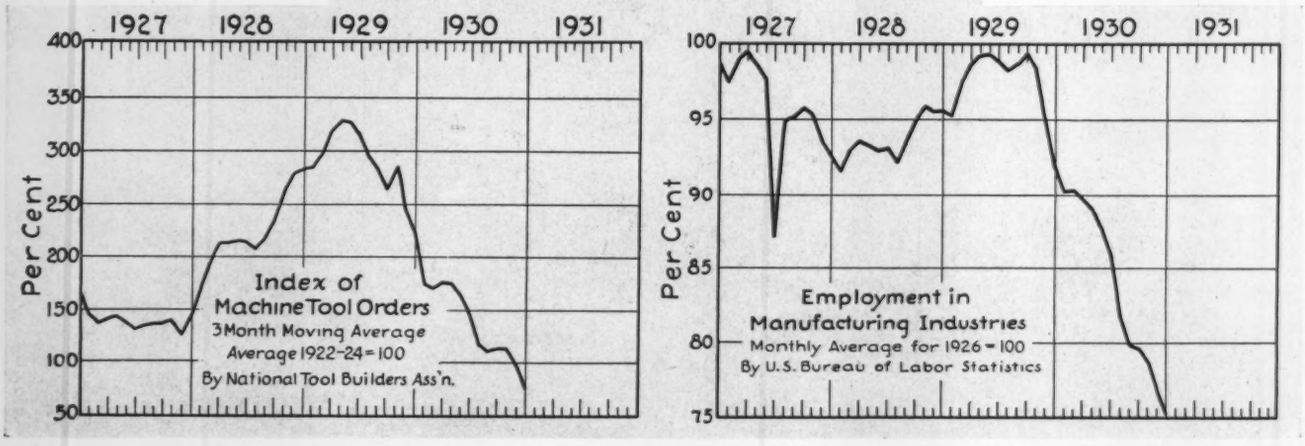
How Is Business?

FEBRUARY finds the new year off to a reasonably good start with business generally showing improvement. Resumption of employment principally in the automobile industry, adds a brighter aspect to the situation and inquiries for materials and parts give a good indication of betterment.

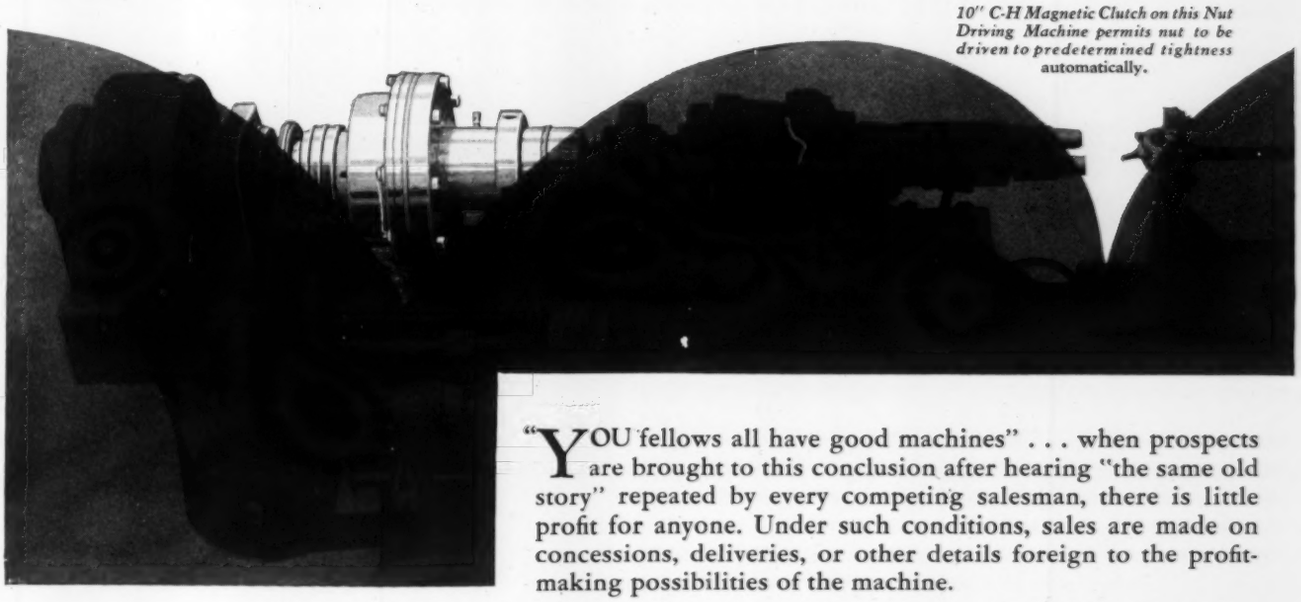
Among those increasing operations in the machinery industry are manufacturers of road building equipment, farm machinery, washing machines and electrical refrigerators. Machine tool sales, notably in the east and middlewest show a gain. This is an unusually good sign because of the bearing the machine tool market has on manufacturing activity in general. Of interest to designing engineers is that engineering details and improvements are playing a big part in machinery sales. Activity in the textile machinery industry in New England is the outstanding feature of machinery business in that locality. The ascent of automobile production has been one of the most important stimulating factors in the metal-working as well as the mechanical industry.

Recent surveys reveal a better business situation than that of a month ago. Basic industries are responding to seasonal influences which point toward revival, and stock and commodity markets have caught the improved tone. Economists assert that although it appears at the moment that the increase in industrial activity has been greater than usual at this time of the year, it remains true that expansion mainly is seasonal in nature.





How far should salesmen's problems dictate machine design?



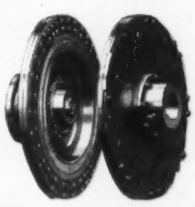
10" C-H Magnetic Clutch on this Nut Driving Machine permits nut to be driven to predetermined tightness automatically.

"YOU fellows all have good machines" . . . when prospects are brought to this conclusion after hearing "the same old story" repeated by every competing salesman, there is little profit for anyone. Under such conditions, sales are made on concessions, deliveries, or other details foreign to the profit-making possibilities of the machine.

A machine may be the best constructed of its kind, yet lack a distinct advantage. Quality is taken for granted. Only quick-registering advantages can lift a machine out of the "just as good" class. To achieve these advantages usually means breaking with tradition.

One of many manufacturers who have found the answer to the problems of their salesmen by incorporating Cutler-Hammer Magnetic Clutches is the manufacturer of the Nut Driving Machine shown above. The C-H Clutch provides the simplest, most precise method of applying power and cutting it off. The clutch slips at a predetermined tightness and this slippage actuates a trip switch disengaging the clutch. Thus the C-H Magnetic Clutch is a safety device in addition to giving absolutely smooth load pick-up. It is the simplest clutch made—and the most adaptable. Any type of switch . . . limit, time, float, etc. . . . will actuate a C-H Clutch.

The booklet CL-1 describes C-H Magnetic Clutches fully and illustrates many other interesting clutch applications. A copy will be mailed at your request.



Built in sizes from 7" to 78"

C-H Magnetic Clutches Provide New, Effective Sales Advantages

C-H Magnetic Clutches consist simply of two parts . . . neither of which is subject to wear or friction. The armature member "dishes" to engage with the field member. Engagement at full speed is smooth, gradual, automatic; without jerk or jar; easy on motor and equipment. Since there is no end thrust and no heavy back-up parts, there is no strain on the shaft or on the driven member.

Engagement pressure is self-contained! C-H Magnetic Clutches are engaged and disengaged by means of push button or foot pedal located any distance away, or by means of limit, pressure, float switches and the like. Used on your machine they provide advantages which are appreciated by your salesmen and your customers alike.

CUTLER-HAMMER, Inc.

Pioneer Manufacturers of Electric Control Apparatus

1326 St. Paul Avenue MILWAUKEE, WISCONSIN

CUTLER HAMMER

Magnetic Clutches Save Time and Save Equipment

A-333

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

ONE of the most important engineering conferences ever held in Detroit, the international annual meeting of the Society of Automotive Engineers, Jan. 19-24, covered such phases of automotive progress as engine design, diesel engines, color trends, lubrication and riding qualities. The subject of torsional vibration dampers, a topic of timely interest, was discussed by D. P. DenHartog and J. G. Baker, of the Westinghouse Electric & Mfg. Co.

Reports of twelve divisions of the standards committee included a proposed standard for lock nuts and washers for ball bearings submitted by the ball and roller bearing division. This included 45 sizes extending up to bearing bores of 8.66 inches. The first 15 sizes were approved as a recommended practice instead of as a standard and the remainder of the table rejected. Revision of recommended practice for spring clips, spacers and bolts was proposed, by specifying that the threads shall be of the American coarse series, Class 2 fit, that the length of threads on screws shall be 1½ diameters plus ¼-inch, and that the ends shall be rounded.

The aircraft division submitted a design for shock absorber strut ends. In addition it proposed that the specifications for bevel washers for aeronautic purposes be canceled.

* * *

Committee Undertakes Standardization Work

STANDARDIZATION of splines and splined shafts which has been undertaken by the sectional committee on small tools and machine tool elements now is receiving consideration by a subcommittee on the subject, according to the American Standards association bulletin.

Two sub-groups were appointed at a meeting late last year in Detroit to initiate the development of spline standards. One sub-group, with R. E. W. Harrison, chief engineer of the Cincinnati Grinders Inc., as chairman, is to undertake the development of spline standards suitable for the machine tool industry; the other sub-group with W. L. Barth, standards engineer, General Motors Corp., as chairman, is to develop suitable automotive and aeronautic standards. Each subcommittee will act independently of the other, although the recommendations of both will be subjected to the approval of the technical committee.

Multiple splines of large diameters are also to be considered by the committee. It was thought, however, by the members present that consideration of this type could be postponed until definite recommendations had been developed for the other type.

* * *

Purdue Research Foundation Is Established

PROGRESS in the movement to promote research gains impetus with the establishment of a research foundation at Purdue university, Lafayette, Ind. Articles of incorporation recently were filed, setting up the Purdue foundation as a non-profit organization whose major purpose is to assist in the financing of research projects and handling of matters pertaining to inventions and patents for benefits of the state at large, the university and industrial organizations directly concerned.

The university during the past few years, particularly, has been the recipient of numerous requests for assistance by Indiana industries in solving scientific problems vital to their growth. These calls have increased with the growing economic importance of the state in national affairs. G. Stanley Meikle, well known consulting engineer, is head of the department which has been handling research relations with industry. Results of his work have led to the organization of the foundation to assume the legal and financial responsibilities of the rapidly expanding research program.

* * *

Aeronautic Commemorative Meeting Planned

TO COMMEMORATE the lives and works of three men who have made outstanding contributions to the art and science of aeronautics, seven great American organizations, the Aeronautical Chamber of Commerce of America, the American Institute of Electrical Engineers, the American Institute of Mining Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the National Aeronautic association, and the Society of Automotive Engineers, will unite in holding an aeronautic commemorative meeting in the Engineering building, 29 West Thirty-ninth street, New York, on Feb. 25.

The program will consist of an illustrated lec-

ture on the aeronautic contributions of the late Glenn H. Curtiss, by Frank Russell, former vice president of the Curtiss Aeroplane and Motor Co., and Capt. John H. Towers, U. S. Navy, and former associate of Glenn Curtiss; aeronautic contributions of the late Chance M. Vought, by Commander E. E. Wilson; and the late Daniel Guggenheim and his encouragement of aeronautics, by Admiral H. I. Cone. The presiding officer will be Col. V. E. Clarke.

Among the special guests that have been invited are relatives and friends of the honored, eminent aeronautic authorities, the presidents of the several societies, Army, Navy and Coast Guard officers, and pioneer flyers. In the foyer will be exhibits of models, structures, instruments, and pictures illustrative of the contributions made by the three men in whose commemoration the meeting is to be held.

* * *

Oil Burner Industry Shows Gain for 1930

SALES of domestic oil burners in 1930 exceeded those of the previous year by approximately 2 per cent. This is an exceptional record in view of the business depression.

At the end of 1929 statisticians predicted that by the end of the current year there would be 650,000 domestic oil burners installed in American homes. Actually based on authentic information there were slightly more than 654,000 burners in use by the end of December, 1930. The sales for the year will be a little over 125,000 burners.

* * *

Automobile Industry Has Important Role

IN THE automobile industry as a whole are engaged directly or indirectly 4,700,000 persons, at an annual wage of $1200 per individual, giving to this group a total purchasing power of over $5,500,000,000 per year, recent statistical research reveals, according to E. G. Henry, manager of Indianapolis Automobile Trade association. The magnitude of the industry is even more astounding when considered as the largest consumer of such materials as gasoline, finished rolled steel and iron, rubber, plate glass and upholstery.

Eighteen per cent of the finished rolled steel and iron is used in the automobile industry, giving employment to more than 70,000 workers. Sixty per cent of all strip steel, 39 per cent of sheet steel, 29 per cent of steel in the form of bars, and 52 per cent of malleable iron is purchased by automobile makers. Thirty-seven per cent of aluminum production in the United States is consumed in producing castings, alloys and sheets for automobiles.

* * *

Two-Day Welding Conference to Be Held

DEMONSTRATIONS of the latest equipment, materials and methods used in the various welding processes and problems of welding as applied to manufacturing, maintenance, and construction will be presented at a welding conference to be held at Case School of Applied Science, Cleveland, Feb. 19-20. At the two-day meeting, under the direction of the school and Cleveland Engineering society, special emphasis will be given to the design of welded structures and machines, and to the influence of welding on the proportioning of such structures and machines.

Subjects to be presented include: New developments in welding; thermit welding; oxyacetylene welding; arc and atomic hydrogen welding; fusion welding of pressure vessels; welding of machine parts and frames; welding of pipe lines; designing for welding; testing welds and welders; and welding of structures. Exhibits and demonstrations planned for the meeting are as follows: Gas welding and cutting, thermit welding; atomic hydrogen welding; automatic arc welding; resistance welding; welding special metals; and testing welds and welding materials.

* * *

"Who's Who In Engineering" Progresses

WITH an exhaustive check for completeness of representation still to be made, the third edition of "Who's Who in Engineering" is halfway finished. Questionnaires were mailed to a general list of about 115,000 engineers. Those who have not received one are invited by the publishers to mail their requests for blanks, to 80 East Eleventh street, New York.

Biographical data should be submitted as soon as possible inasmuch as the time rapidly is growing shorter. After the sketch has been placed in conventional form it is submitted to the engineer supplying it, for final check on its accuracy. The third edition will be approximately the same size as the second and should be in the hands of subscribers before summer, dependent upon the speed with which the final data is secured from delinquent engineer correspondents.

* * *

Draft of Proposed Standard Is Circulated

A REVISED draft of the proposed American standard for fabrication of hangers, supports, anchors, sway bracings, and vibration dampeners, prepared by the sectional committee on pressure piping organized under the procedure of the American Standards association, now is being circulated for comment and criticism. Copies are available through the American Standards association, 29 West Thirty-ninth street, New York.

The new draft includes a number of revisions made in the previous draft which was circulated several months ago. The committee which is working on the project is under the sponsorship of the American Society of Mechanical Engineers.

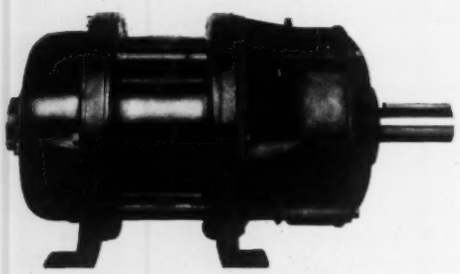
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Designs Unique Speed Reducer

HELICAL gear reduction units are built into the end shield of a standard electric motor to form front gear motors, a development of the Watson-Flagg Machine Co., Paterson, N. J. Except for a slight increase in overall length, together with a larger shaft diameter than usual, because of the lower speed involved, the combination is practically the same in appearance as the motor alone. The wire spread, double bearing supports for the output shaft extension permit the application of these units on overhung load conditions, such as V-belt or roller chain take-offs, in addition to the usual coupling connection.

The front gear motors are equipped with antifriction bearings throughout, and are dustproof and oil-tight. Standard N. E. M. A. motor



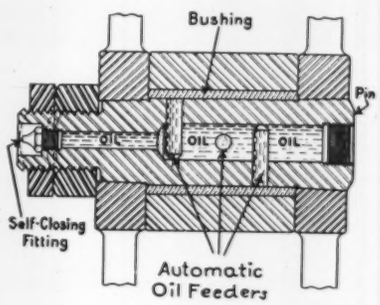
Front gear motor developed to provide speed reduction

frames are employed, and the combination is entirely supported on the regular motor feet. No unit bedplate required and there is provided simplified, quiet, motor speed reduction. These front gear motors are available for any speed motor from 3600 revolutions per minute down and from 1/6 to 30 horsepower stock ratios are 11-2/3:1, 11:1, 10-1/3:1, 9:1, 8:1, 7:1, 6:1, 5:1, and 4:1.

Oil Feeders Lubricate Effectively

LUBRICATION of moving machine parts with oil is accomplished effectively by automatic oil feeders developed by Nathan Mfg. Co., New York. Oil reservoirs are built into parts equipped with this lubricating system. In holes which connect the reservoirs and bearing surfaces, oil feeders or plugs are fitted for carrying the oil to the bearing surfaces.

The wood from which this new automatic oil feeder is constructed has unusual feeding char-

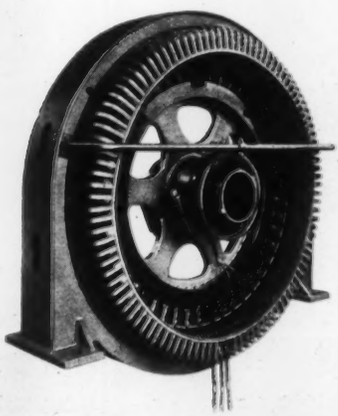


Cross section showing construction of automatic oil feeder

acteristics. Through a patented treatment this natural power is considerably amplified. The end of the feeder which discharges oil makes a perfect bearing surface. Because of its peculiar cellular structure, it will not glaze or clog. Just the proper amount of oil to thoroughly lubricate is discharged, with a minimum of attention required.

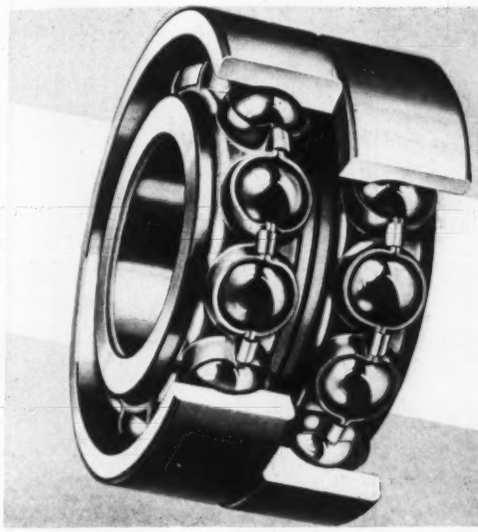
Stator Is Box Type Construction

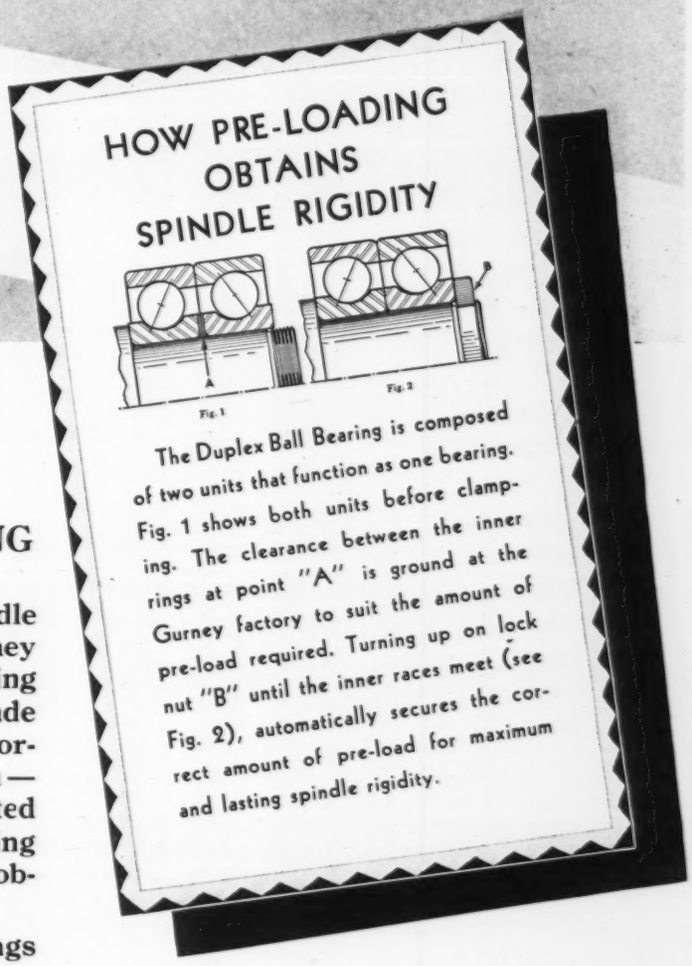
USE of arc welded fabricated steel stator in the construction of all medium and slow speed E-M synchronous motors has been an-



Synchronous motor in which the stator is constructed by arc welding. Uniformity of appearance and general details is accomplished

SPINDLE BEARINGS tested by time




HOW PRE-LOADING OBTAINS SPINDLE RIGIDITY
Fig. 1
Fig. 2
The Duplex Ball Bearing is composed of two units that function as one bearing. Fig. 1 shows both units before clamping. The clearance between the inner rings at point "A" is ground at the Gurney factory to suit the amount of pre-load required. Turning up on lock nut "B" until the inner races meet (see Fig. 2), automatically secures the correct amount of pre-load for maximum and lasting spindle rigidity.

16 Years of Experience Back of the

GURNEY DUPLEX BALL BEARING

The Gurney Duplex (pre-loaded) spindle bearing has been manufactured by the Gurney organization for over sixteen years. During this time many improvements have been made in Duplex design and construction. Its enormous thrust capacity—its extreme precision—its close race curvatures — all are time tested refinements that makes the Duplex ball bearing of today the most efficient spindle support obtainable.

Applying this bearing to spindle mountings has been a business with Gurney engineers for many years. Pre-loading—a new word in the machine tool vocabulary—describes duplexing—a mounting method introduced by Gurney engineers 16 years ago.

The Gurney Duplex offers more to the machine tool industry than just spindle rigidity—it offers time tested proof of its merits and an engineering service based on proven experience. GURNEY BALL BEARING DIVISION, Marlin-Rockwell Corp., Jamestown, N. Y.

GURNEY BALL BEARINGS

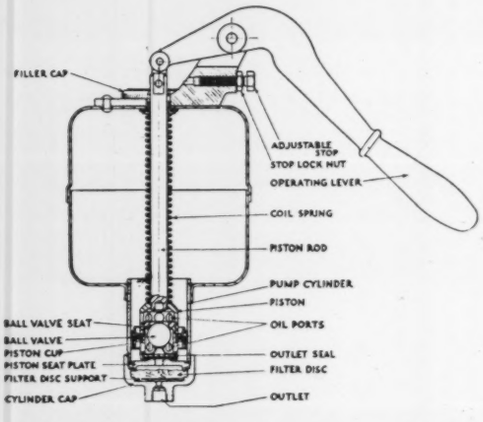
nounced by Electric Machinery Mfg. Co., Minneapolis. A recent change from a two-piece cast iron stator to a welded steel stator for small size motors completes the changeover to fabricated steel stator frames.

This departure makes the entire line of engine type and coupled pedestal type synchronous motors uniform in appearance and general details. The box type stator construction is used for all slow speed synchronous motors, providing increased strength and rigidity, decreased weight, increased ventilation, more pleasing appearance, and uniformity of construction.

Delivers Oil Under Pressure

CENTRAL lubrication by means of a system developed specially for industrial machinery has been announced by Bijur Lubricating Corp., New York. The system consists of an oil reservoir and pump to force the oil, piping to distribute the oil under uniform pressure, and control devices, called drip plugs, located at the bearings.

Depression of the pump handle, shown in the accompanying illustration, loads the cylinder with a predetermined quantity of oil. Release of the handle places this oil under a pressure of approximately 50 pounds per square inch. The



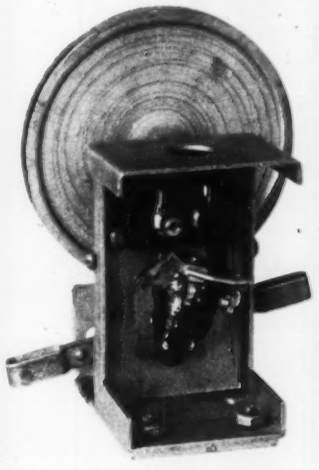
Oil reservoir and pump which forces lubricant through system

pump and reservoir are a self-contained unit and may be located at any convenient place on the machine. In the normal position, the pump piston is held down by the operating spring and the pump outlet is mechanically closed. When the pump is operated, the piston is raised against the downward pressure of the coil spring. During the upstroke, a charge of oil is drawn through the oil ports in the piston and around the ball into the space under the piston. When the pressure is removed from the operating lever the coil spring forces the piston down, and the upward rush of oil lifts the ball valve to its seat in the piston.

The measured charge of oil trapped in the cylinder below the piston then is forced into the lines by the pressure of the spring. The stroke of the piston is adjustable by means of a stop screw and lock nut so that any predetermined amount of oil may be fed into the lines at each operation of the pump. A dense felt filter disk prevents any dirt or solid matter from entering the system.

Float Switch Has Mercury Contacts

USE of a mercury switch as part of a new float switch (CR-2931-U) recently announced by the General Electric Co., Schenectady, N. Y., makes the device suitable for use



Float switch for use where total enclosure of the contacts is desirable. Mercury type contacts make it suitable for heavy duty

in atmospheres where open type, mechanical contacts might be subject to corrosion, or where, for other reasons, it is desirable totally to enclose the contacts. In addition the mercury type contact makes the device suitable for heavy duty, and thus it can be used for throwing motors directly on the line up to the following capacities:

Circuit	Motor horsepower	Voltage	Amperes Capacity Switch
Alternating current, single-phase	½	110	10
		220	5
		550	2½
Alternating current	¼	110	10
		220	5
		550	2½
Direct current	¼	80	15
		125	10
		250	5

Float switches are used where control is to be actuated by the level of a liquid in a tank or other reservoir. For example, where it is desired to replenish a reservoir, when the water falls to a predetermined minimum, the switch can actuate control devices which will start a motor-operated pump at the proper time.

The mercury switch used in the new float switch is known as a Kon-nec-tor and is a product of the General Electric Vapor Lamp Co. It consists of a hard glass envelope containing

No. 1 of a series of data sheets for the use of engineers in applying Texrope Drives to all classes of equipment.

CORRECT ENGINEERING PRODUCES MAXIMUM LIFE OF V-BELTS

The proper selection of the sheaves and belts for Texrope Drives has much to do with the life of the belts and the satisfactory performance of the drive.

Having originated the Texrope V-Belt Drive and developed it to its present perfection, Allis-Chalmers presents authentic data of vital importance to engineers.

It should be remembered that when the diameter of the driver sheave is less than an established minimum, the belts will not give long service.

Bending a belt over too small a pulley is much the same as driving a car with the tires under-inflated. The cord is subjected to constant flexing at a sharper angle than it should be . . . consequently, it wears out. This is true of *any* V-drive.

For this reason Texrope Drives are correctly engineered to be sure that sheaves of largest diameters are used, always considering that good practice demands a belt velocity of 4000 ft. per minute for the most economical operation.

Allis-Chalmers has established five different widths or cross sections of Texrope belts, each designed to cover a range of horsepowers and speeds. The thickness of the five belts varies according to the width, and each cross section calls for a minimum recommended sheave diameter. The standards established by Allis-Chalmers are given in the illustration.

Another important detail in correct engineering is that the tops of the belts should be a little *below* the tops of the sheaves. Otherwise the edges of the sheaves have a tendency to "cut" into the sides of the belts . . . and reduce their capacity.*

The correct design of a Texrope Drive is an important factor in its life and efficiency. Over 100,000 Allis-Chalmers Texrope Drives are now in service. Wherever correctly applied they give complete satisfaction.

Allis-Chalmers standards are the result of over five years' experience, observation and tests. The Texrope Tex-Book is an engineering data book full of useful facts. Write for your copy.

Each branch office of Allis-Chalmers offers an engineering service of which you are invited to take advantage. Phone or write the one nearest to you.

ALLIS-CHALMERS MANUFACTURING COMPANY—*Texrope Division*
MILWAUKEE ***Specialists in Power Machinery Since 1846*** **WISCONSIN**

Atlanta, Ga., Baltimore, Md., Birmingham, Ala., Boston, Mass., Buffalo, N. Y., Charlotte, N. C., Chattanooga, Tenn., Chicago, Ill., Cincinnati, Ohio, Cleveland, Ohio, Dallas, Texas, Denver, Colo., Detroit, Mich., Duluth, Minn., El Paso, Texas, Grand Rapids, Mich., Houston, Texas, Indianapolis, Ind., Jackson, Mich., Kansas City, Mo., Los Angeles, Calif., Milwaukee, Wis., Minneapolis, Minn., New Haven, Conn., New Orleans, La., New York, N. Y., Philadelphia, Pa., Phoenix, Ariz., Pittsburgh, Pa., Portland, Ore., Richmond, Va., St. Louis, Mo., Salt Lake City, Utah, San Antonio, Texas, San Francisco, Calif., Seattle, Wash., Shreveport, La., Spokane, Wash., Tampa, Fla., Toledo, Ohio, Tulsa, Okla., Wilkes-Barre, Pa.

ORIGINATED BY ALLIS-CHALMERS

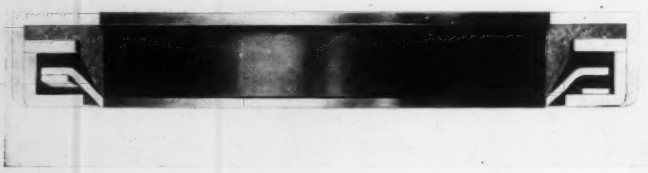
TEXROPE DRIVES

THE DRIVES THAT REVOLUTIONIZED TRANSMISSION PRACTICE • • •

a quantity of mercury and having two inleading wires. The envelope is so constructed that when the switch is in the closed position the mercury forms a continuous stream from one inleading wire to the other.

Oil Seals Insure Tight Joints

PRECISION oil seals for slow and high speed applications recently were placed on the market by Gits Bros. Mfg. Co., Chicago. A feature is their capability of operating equally well on horizontal or vertical shaft application. Prevention of oil loss with minimum friction is attainable through their use.



Sectional view showing unit construction of oil seal incorporating leather flanges

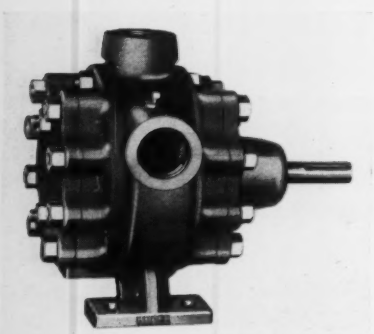
Seals are made for ball, roller and plain sleeve bearing enclosures. Heavy sheet steel, accurately formed to insure minimum eccentricity and an oil tight joint when pressed into the bearing housings, is used in the manufacture of these seals. The leather flanges are made of selected material accurately formed to close limits. Units are assembled ready to install and are recommended for use on shafts operating up to 500 peripheral feet per minute.

Develops New Pressure Pumps

IN KEEPING with the new era of hydraulic power development, the Geo. D. Roper Corp., Rockford, Ill., recently announced a perfected series of dependable pressure pumps for use against pressures up to 1000 pounds per square inch.

The units can be used successfully as the prime mover for pumping oil directly against the cylinder or ram which in turn operates the various mechanisms, and are also fitted for pumping into an accumulator tank. Pressure lubricated, leak-proof stuffing box, herringbone gears—no end thrust, always primed, quiet in operation, extra close bolt spacing, and extra heavy construction are features of Roper pressure pumps.

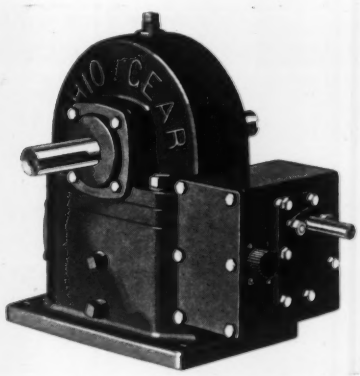
They can be furnished suitable for building into or as a component part of a machine. Moreover, they can be mounted on bedplate with outboard bearings and pulleys, for belt, or chain drive, or mounted on a bedplate for direct connection to motor. Hydraulic power for application on any machine or service requiring dependable, smooth, economical power with pressure up to 1000 pounds is obtainable through use of the new pumps.



High pressure ball bearing pump made in four sizes for hydraulic power transmission

Reduction Unit Has Varied Uses

COMBINING the high speed reduction advantages of work gearing with a selective dial which permits any of four speed changes to be used, a new speed reduction unit recently was placed on the market by Ohio Gear Co., Cleveland. Its applications are diversified and sizes ranging from 3 horsepower to small fractional horsepower soon will be available.



Combination speed reducer and four-speed changer unit. Worm wheel is bronze and runs in oil bath

Essential parts of the unit are the worm and worm wheel assembly which provides the main reduction; and the speed changer box. Worm and worm wheel may be arranged for practically any reasonable ratio. The speed changer also can be varied within fairly wide limits, although for most purposes it has been found that the two alternative sets of ratios which have been standardized are sufficient.

The first alternative varies the revolutions per minute in the proportions of one to one, one and a half to one, two to one and three to one, as compared with the worm wheel revolutions. The second alternative standard varies as two to one, 1.87 to one, 1.66 to one and 1.6 to one. These ratios must be multiplied by the ratio of the worm gear reducer to which the speed changing part is attached in order to give the

Not what you pay for dies *but* what you pay for *Stampings*

The separator manufacturer for whom these parts were made, found that G. P. & F. could supply better stamped parts at less cost than he could make in his own plant.

PLANS and estimates incorrectly made, unforeseen charges "bobbing up" later on, a high percentage of "rejects" . . . these or others are the penalties of too much emphasis on die charges.

When you come to G. P. & F., you can be certain of an intelligent solution of your problem, of dies made exactly for the purpose, at *lowest* cost. You can be certain that the quoted cost is the absolute cost, that every short-cut to cost-reduction has been considered in the estimate. You may even find that we already have part of your needed tools on hand—again assuring you of an absolute savings. More than 50 years of experience, a plant covering 19 acres, assure you an A-1 stamping job . . . and prompt, speedy delivery on every order.

The booklet, "In Harmony with Modern Progress", tells more about G. P. & F. economies and the complete story of what can be done with pressed metals. It is sent, without obligation.

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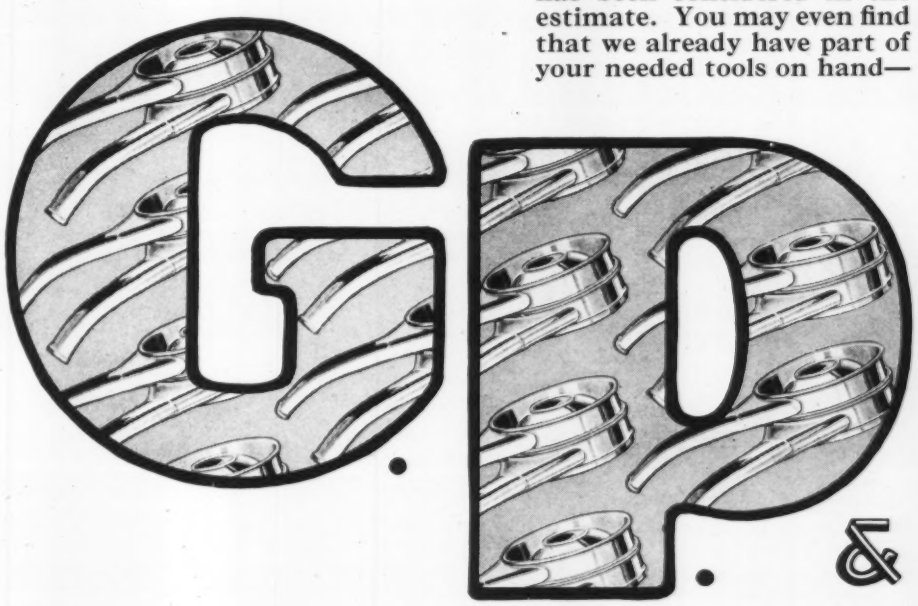

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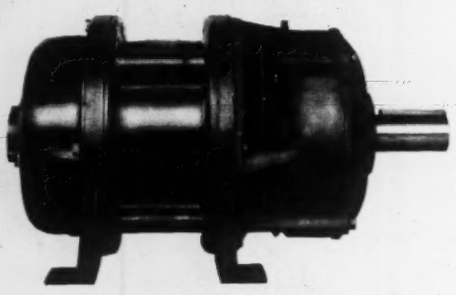


Front Gear Motors with WATSON-FLAGG Built in Helical Gear Reduction Units

FEATURES

All gear reduction with helical gears

Quiet in operation

Highest efficiency—Full anti-friction bearings

Dustproof—Oil tight—Internal oiling system for bearings and gears

Rugged—Built to transmit any load motor will start—Overhung loads permissible on shaft extension same as standard motor

Easy to install—Saves labor and space

STOCK SIZES

1/6 to 30 H.P. 3600 R.P.M. Down. Standard Gear Ratios 11-2/3:1, 11:1, 10-1/3:1, 9:1, 8:1, 7:1.6:1.5:1.4:1.

Unlimited variety special ratios furnished to order.

Write for Bulletin 3

WATSON-FLAGG MACHINE CO.

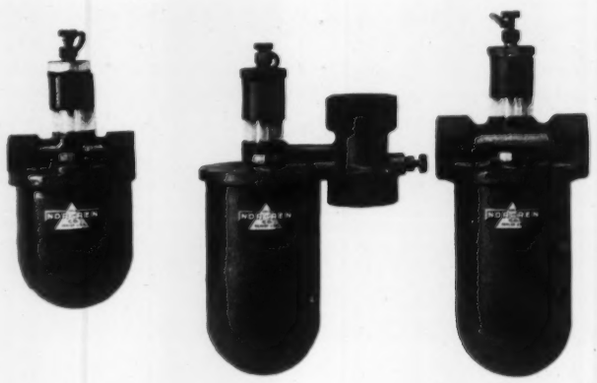
Paterson, N. J.

ultimate reduction. Thus, for example, with an 1800 revolution per minute motor and a ten to one worm gear reduction, the speeds available at the worm shaft with the first alternative would be 180, 120, 90 and 60 revolutions per minute.

The worm is hardened and ground steel, and the worm wheel is bronze and runs in an oil bath. The reducer shafts run in ball bearings. Edges of the speed changer gear teeth are rounded to facilitate easy engagement when operating the selective dial, and as a further precaution against breakdown the mechanism is so designed that the "gear-shift" dial cannot be operated unless the unit is at rest. Sufficient clearance is also allowed so that no two sets of gear trains can be in mesh at the same time. Both the box and the worm assembly can be arranged for any operating position specified.

Lubricators Are Air Line Type

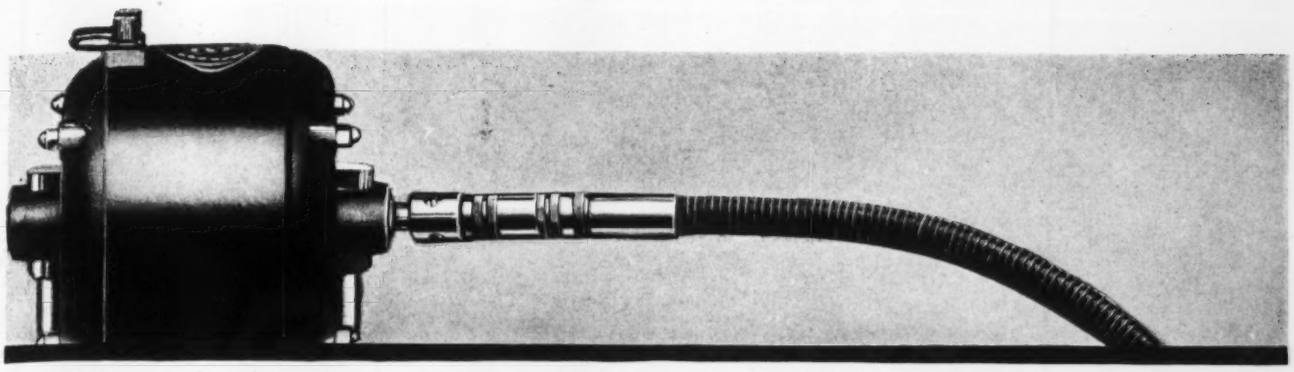
DESIGNED to automatically maintain a positive and continuous supply of lubricant in an air stream, a recently developed sight-feed air line lubricator is being manufactured by Carl A. Norgren Co., Denver, Colo., and distributed by J. N. Fauver Co., Detroit. Oil is supplied only when the air in the line is in motion. The unit, three types of which are shown in



Sight-feed automatic air line lubricators

the accompanying illustration, is adjusted by a needle valve, making possible any degree of feed. By means of the sight feed the operator readily can see the amount of oil the machine is receiving.

Brass and bronze construction, with pressed steel reservoir insure long life to the lubricators. Applications include molding machinery, air chucks, chippers, hammers, riveters, and more recently its use in connection with hydraulic machinery where some air is employed for a movement. Sizes available range from 3/8, 1/2, 3/4 to 1-inch sizes. The size required for a particular tool is indicated by the pipe for the air connection on the tool.



When You Buy Flexible Shaft Machines be Sure they are Equipped with

S. S. WHITE FLEXIBLE SHAFTS

Partial List of Applications Using S. S. WHITE SHAFTS

- Valve Grinding Machines
- Screw Slotting Machines
- Linotype Machines
- Milling Machines
- Glass Cutting Machines
- Surgical Engines
- Dental Engines
- Boiler Tube Cleaners
- Tachometers
- Speedometers
- Counting Attachments
- Taximeters
- Gun Fire Controls
- Moving Picture Cameras
- Moving Picture Projectors
- Washing Machines
- Testing Machines
- Massage Machines
- Hair Clippers
- Valve Controls
- Printing Presses
- Odometers
- Engine Governors
- Animal Shearing Machines
- Indicator Mechanisms
- Windshield Cleaners
- Searchlight Controls
- Floor Scraping Machines
- Portable Grinders etc.
- Paint Scraping Machines
- Shoe Machinery
- Engraving Machines
- Jewelers' Lathes
- Concrete Surfacers
- Airplane Radio Receivers

Of the many factors that enter into the selection of a portable flexible shaft machine, none is more important than the shaft itself.

Leading manufacturers of such machines appreciate this fact and therefore, equip their products with S. S. WHITE Shafts. They know that by so doing they are supplying the best there is in flexible shafts,—shafts in which easy flexibility has been obtained without sacrifice of strength; shafts that are true-running and that keep on running, trouble-free over long periods even in severest service; shafts that reflect in their finished quality, the 86 years of progressive manufacturing experience back of them.

If you would be sure of satisfactory service from every angle, specify on your order for flexible shaft machines, "Must be equipped with S. S. White Flexible Shafts."

Write and tell us what type and size of flexible shaft machines you are interested in, and we shall let you know where you can get them with S. S. White Shafts.

Or, if you manufacture a product in which a flexible shaft is used or could be used to advantage, we'll gladly give you full details and quotations on S. S. White Shafts.

This HANDBOOK-Free

Contains complete data on flexible shafts and their application. Write for a copy on your business letterhead stating your position.

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INDUSTRIAL DIVISION

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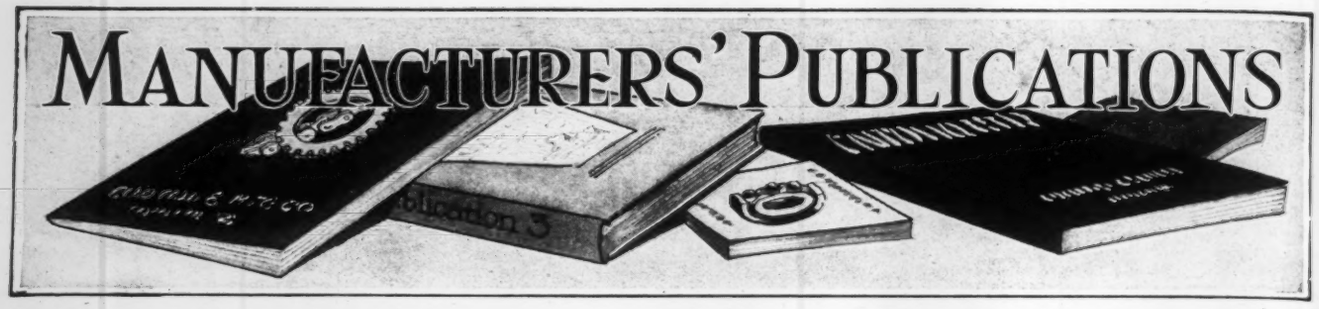


Publications listed in this section may be obtained without charge from the manufacturers of the products or through MACHINE DESIGN

SPEED REDUCERS—Foote Bros. Gear & Machine Co., Chicago, has in preparation a new data book and catalog on its line of worm gear speed reducers. It will cover evolution of the worm gear, design, materials, manufacturing methods, and selection of types. Included are data tables, curves, formulas, working problems, and illustrations.

ELECTRICAL EQUIPMENT—General Electric Co., Schenectady, N. Y., has issued a number of bulletins, as follows: Photoelectric relay; phase protective panels; fractional horsepower motors; squirrel-cage induction motors; steam turbines; mechanical-drive turbines; oil circuit breakers.

TECHNICAL DATA—Square D Co., Detroit, Milwaukee, and Peru, Ind., just has issued a 4-page bulletin written by J. G. Jackson, its director of engineering. The publication deals with heating in switches and panelboards. Another bulletin describing a safety panel (convertible) also is being circulated.

HEAT CONTROL—Control of heat as an essential factor in keeping heat treating costs down is stressed in a folder by the Brown Instrument Co., Philadelphia. It shows application of its pyrometers and automobile control instruments in thirty styles of furnaces designed for heat treating of metals. It is a graphic presentation of the breadth of application of these devices.

AIRCRAFT ENGINES—A directory of American aircraft engines, giving ratings, characteristics and special features, has been compiled by the International Nickel Co., 67 Wall street, New York. A page is devoted to each model. Data includes a photographic reproduction, type, rating, weight, fuel and oil consumption and a list of nickel alloy parts.

VARIABLE SPEED CONTROL—A handbook covering the subject of variable speed control has been issued by the Reeves Pulley Co., Columbus, Ind. It covers specific requirements for speed control, engineering data, descriptions of new designs of Reeves variable speed transmissions, service manual covering installation and maintenance and a service record for listing transmissions in use. The designing engineer will find this handbook both interesting and helpful.

COMPRESSORS—Three bulletins have been issued by the Sullivan Machinery Co., Chicago, covering types of air compressors. A vertical, high pressure compressor is a new development. It is a single stage compressor driven by electric motors. Capacities are 120 to 240 feet. The other bulletins cover a straight-line compressor and a high pressure compressor. All are illustrated completely and contain engineering data.

V-DRIVE—Worthington Pump & Machinery Corp., Harrison, N. J., is circulating a leaflet calling attention to the multi V-drive for efficiently connecting motor and machine, giving positive drive and minimizing loss of power.

ELECTRICAL EQUIPMENT—General Electric Co., Schenectady, N. Y., has issued a number of bulletins on various items of its equipment. They include centrifugal compressors, motors, thermostat, switches, resistors, and control equipment.

VALVES—Edward Valve & Mfg. Co., East Chicago, Ind., has prepared a circular outlining its care in production of valves for high temperature use and presents a list of users whose requirements are high.

SPECIAL IRON—Dodge Mfg. Co. Ltd., Toronto, Ont., has issued a bulletin describing qualities and characteristics of its special sorbitic iron for uses where high resistance is required.

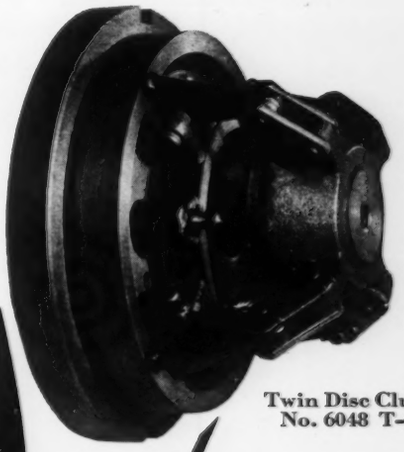
ALLOY STEEL—Darwin & Milner, 1260 West Fourth street, Cleveland, is distributing a booklet on its high carbon, high chromium steel, for use in quantity production press tools.

PLANER MOTORS—Bulletin No. 207 has been issued by the Reliance Electric & Engineering Co., Cleveland, covering its type T heavy duty planer motors for reversing service. Every part of the motor is illustrated and fully described. Typical installations in planer service are shown in halftones.

INDUSTRIAL ELECTRIC HEAT—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., devotes a current catalog of its electric heating devices to their application to industrial uses, a field which has been growing rapidly. Illustrations of heating devices are supplemented by charts showing heating curves and results of various degrees of heat.

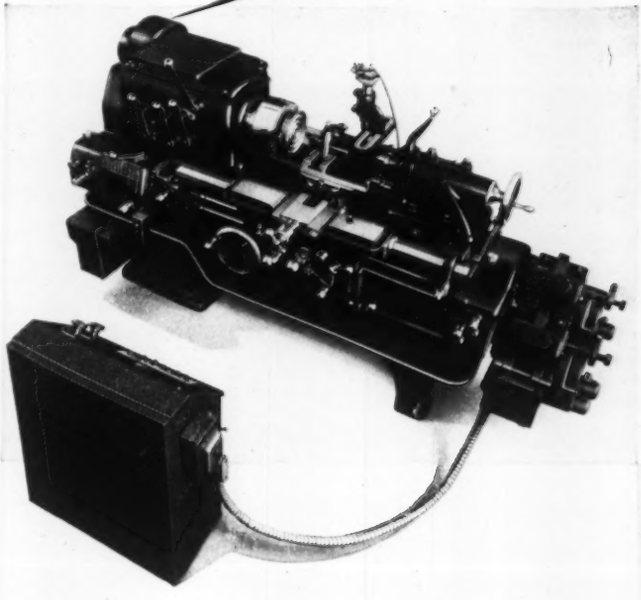
ALUMINUM WIRES—General Cable Corp., New York, in a current bulletin describes its line of insulated aluminum wires and cables. The bulletin presents a technical discussion of conductivity, weight, strength, impedance skin effect, and current carrying capacity, with a table of comparisons. Consideration is also given to applications of these wires and cables and specific examples of their applications.

A most REVOLUTIONARY LATHE DEVELOPMENT...



Twin Disc Clutch
No. 6048 T-6½

The latest contribution of the Monarch Machine Tool Co., Sidney, Ohio, toward broadening the field for the use of lathes ... the Monarch-Keller Automatic Form Turning Lathe in sizes from 14 in. to 36 in. swing ... combines a standard engine lathe and an automatic form turning lathe. It is a Monarch Lathe with Keller automatic electrical control, and Twin Disc Clutch, *built-in* to form a complete unit.



Especially adapted for die and mould making and for turning many other intricate and odd shaped pieces... the use of this machine enables many jobs, ordinarily taking a day, to be completed in an hour or so.

The Twin Disc Clutch is a cut-off clutch and drives the entire main control. And it is particularly significant that *Twin Disc Clutches* are used *exclusively* on *all sizes of Monarch Lathes.*

Adaptable and compact, Twin Disc Clutches ... in stock models and sizes as well as special models ... meet modern methods of design and the highest machine tool standards of capacity, smoothness, all-around dependability and economy. Our Engineering Research Department will understand your clutch needs ... *write for recommendations.* Engineering Data Book on request. *Twin Disc Clutch Company, Racine, Wisconsin.*

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